

The Blast Furnace Steel Plant

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The Blast Furnace *and* Steel Plant

Vol. XIII

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No. 11

Shakespeare and Steel

STUDENTS of Shakespeare are wont to marvel at his intimate knowledge of things material. The sources of his information must have been drawn first hand. Iron and steel aroused his keen imagination, and he frequently drove home his argument by reference to these known quantities. To him steel was the **ULTIMATE**. His frequent quotations are interesting.

"Between two blades, which bears the better temper?"

"It is a sword of Spain, the ice-brook's temper."

"With hard bright steel."

"When steel grows soft as the parasite's silk."

"Never did the Cyclops' hammers fall on Mars' armour forged for proof eterne."

"This lump of ore will be melted."

"Here's the note how much your chain weighed to the utmost caret."

"Come to the forge with it then; shape it. I would not have it cool."

"Fetch me an iron crow."

"The cannons have their bowels full of wrath."

"Are you more stubborn-hard than hammered iron?"

"I saw a smith stand with his hammer whilst his iron did on the anvil cool."

Direct Process for Manufacture of Steel*

Iron and Steel Produced Direct from Ore in One Single Process
Are Superior to Either Open-Hearth or Bessemer
Products, According to Author's Claims

By HENNING FLODIN†

THE following paper describes a series of experiments in the direct smelting of ore by electric means, carried out at the Electro-Chemical Section of the Royal Technical High School at Stockholm during the years 1923-25. It may be mentioned that the Electro-Chemical Section of the above-mentioned establishment, the principal of which is Professor Wilhelm Palmer, is equipped with a special electro-metalurgical laboratory, open at a nominal cost to qualified inventors, so that they may elaborate their ideas to the benefit of the industry by carrying out experiments on a sufficiently large scale to be of practical and scientific value.

The object of these trials was to ascertain whether malleable iron and steel can be extracted direct and continuously from iron ore, and at the same time to reduce the percentage of phosphorus and sulphur content in the ore and coal. An electric furnace was specially constructed for the purpose, working with a load of about 30 kilowatts.

A few trials alone sufficed to establish that iron with carbon from 0.02 per cent and upwards could be produced without difficulty. In order to prove that this was not merely a chance result from a small number of smeltings, 65 such trial reductions were made in a furnace of the particular construction mentioned, the results of which fully bore out that the method pursued was on the right lines. The effects were so encouraging that, on the initiative of Mr. G. Cornelius and Mr. A. Hammarberg of Stockholm, it was decided to test the process thoroughly on a reasonably large industrial scale at the iron works at Hagfors, Sweden. An electric furnace with a load of 250 to 300 kilowatts was used, and up to the time of writing 114 tappings have been made.

Analyses made at the chemical laboratory at Hagfors show the composition of the product to be:

Carbon	— from 0.02 per cent to 1.32 per cent.
Phosphorus	— from 0.003 per cent to 0.017 per cent.
Sulphur	— from 0.009 per cent to 0.077 per cent.

*Paper presented at the September meeting of the (British) Iron and Steel Institute.

†Stockholm.

The following results of tests carried out by Mr. O. Caspersson, engineer, indicate the physical and mechanical properties of the iron and steel produced:

It may here be observed that, during one of the furnace runs at Hagfors, the author was requested to vary the proportion of carbon in several successive tappings:

Required. Per cent Carbon	Results. Per cent Carbon
(1) 0.40	0.42
(2) 0.20	0.23
(3) 0.80	0.78

Thus it was found that there was no difficulty whatever in producing iron and steel of any desired carbon percentage at successive tappings without interruption of the process, showing that the process can be controlled in the same manner and quite as easily as the discontinuous open-hearth process. The manganese and silicon contents are controlled in the same manner as in the open-hearth process. From the heat No. 3 containing 0.78 per cent carbon, an ingot was taken and rolled out at the Forsbacka Ironworks, Sweden, and the material was used for making chisels for pneumatic hammers, drills, and miners' sledges, mainly for the purpose of testing the material. The chisels have proved to be fully equal to those made of the firm's own Bessemer steel, and nearly as good as those made of special steel alloy for the cutting out of blanks of hard steel and chrome steel (1.40 per cent chromium, 1.10 per cent carbon). The drill penetrated 0.4 metre into granite in a wet borehole without regrinding, and 0.6 metre into hard sandstone bored dry. Better results cannot be obtained with the best Bessemer steel. The sledges were even superior to those made of 1A Bessemer steel.

The total radiation surface of the experimental furnace at Hagfors was 30 square metres, and when running empty the furnace took about 100 kilowatts. At a load of 300 kilowatts the furnace was therefore working with 200 effective kilowatts.

A 3000-kilowatt furnace has a radiation surface 2.5 times larger than the experimental furnace, or 70

TENSILE TESTS

No. of Tapping.	Yield Point. Kg./mm. ²	Tensile Breaking Strength. Kg./mm. ²	Elongation* per Cent.	Reduction of Area.	Condition of Test-Piece
19	24.3	32.4	34.0	59	As rolled.
26	22.2	32.5	30.0	64	Turned from 25 mm. square, rolled bar.
27	25.4	35.3	28.5	65	Turned from 28 mm. square, rolled bar.
41	....	40.8	29.5	63	Turned from 12 mm. round, rolled bar.
42	....	45.8	12.0	61	Wire, as rolled.
42-1	....	37.7	29.0	73	Wire, as rolled and annealed.
56	31.8	45.8	25.0	54	Turned from 28 mm. square, rolled bar.
16	36.2	47.2	24.7	43	As rolled.
60	45.8	89.8	8.5	15	Turned from 28 mm. square, rolled bar.

*The elongation is measured on a gauge length of 10 times the diameter of the test-piece.

square metres, so that the heat loss would be $2.33 \times 100 = 233$ kilowatts.

In this furnace the effective load is therefore $3000 - 233 = 2,767$ kilowatts. The losses due to water-cooling in the moulds, in contact rings and refrigeration, etc., amount to 263 kilowatts, making the total loss 500 kilowatts.

The loss on current at a load of 300 kilowatts in the experimental furnace was 33.3 per cent. In the 3000-kilowatt furnace it was 16.65 per cent. The loss on transformers and lines is not included, as the measurements were taken close to the furnace. For this moderate expenditure of energy the price is not so important a factor as one would be induced to expect at the first glance.

At a load of 300 kilowatts 1 ton of iron was produced in the experimental furnace, with an expenditure of 2700 kilowatt-hours. Deducting 100 kilowatt-hours for empty running, the production thus amounted to 111 kilogrammes per hour.

The 3000-kilowatt furnace is to work with a net amount of 2500 kilowatts (3000 less 500 kilowatts loss). The production will therefore be:

$$\frac{2500 \text{ kwh.} \times 111 \text{ kg. per hour}}{200 \text{ kwh.}} = 1388 \text{ kg. per hour}$$

The gross expenditure of energy in the furnace will thus be:

$$\frac{3000}{1.388} = 2,162 \text{ kwh. per ton of iron.}$$

The heat content of the waste gases amounts to between 2,700 and 2,900 calories.

If in Scandinavia the cost of hydro-electric energy is put at 50 to 60 crowns (55 to 66 shillings) per kilowatt-year, it is evidently cheaper than steam-power. According to American statistics, the price of water-power is \$15 to \$25 per kilowatt-year, and the cost

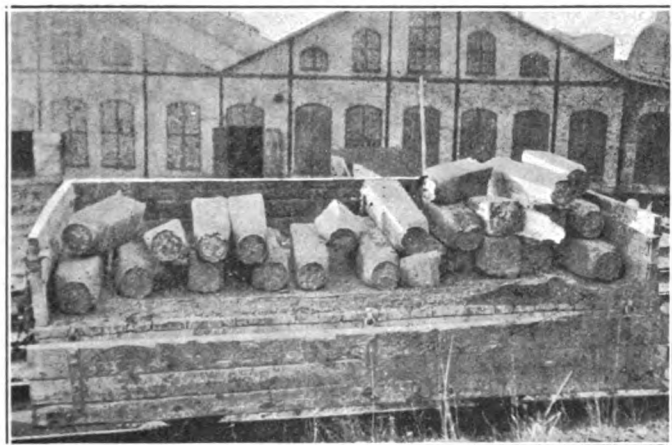


FIG. 1.—Ingots produced by direct process.

of power from large steam-power stations is \$20 to \$25 per year. These prices of course only hold good for a constant load by day and night. With regard to future power stations installed at a great cost to take a maximum load for some few hours per day only, the conditions are of course different.

With respect to the method itself, it is unnecessary to point out that in this direct process the previous production of pig iron is dispensed with. The process works direct on a mixture of ore and coal in a single furnace, and the product is in the form of malleable

iron and steel capable of being teemed into chills or other moulds in the usual manner. The process, however, does not only work direct as "one single process," but is continuous, interruptions occurring only at the moments of tapping, when the continuous feeding in of the mixture of ore and coal ceases, to recommence immediately after the tapping is complete. The operations must, of course, be carried out in such a manner that the furnace is fed with the mixture of coal and

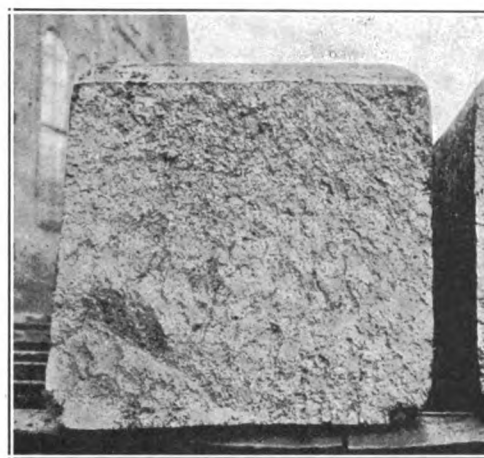


FIG. 2.—Fracture of Ingot made by direct process.

ore in quantities corresponding to the capacity of the amount of electric energy supplied for reduction and fusion.

The reduction of the iron proceeds uninterruptedly and continuously. The metallic iron particles reduced from the ore may be compared to a fine rain continually dropping through the slag bath to the bottom of the furnace, where the molten malleable iron constantly accumulates. Practically speaking, the iron is in a fit condition at any moment for tapping in varying quantities in proportion to the rate of reduction, and it is hardly to be imagined that a higher degree of continuity can be reached in any process for the production of iron.

The raw materials used at Hagfors in the experimental furnace are Swedish haematite ore, and both English pit coal and Swedish charcoal. No refinement in special furnaces is necessary for the removal of phosphorus and sulphur to a sufficiently low point, the process being based on the principle that in the reaction the molecules are in contact, thus facilitating the transfer of the phosphorus and sulphur to the slag. A specially low-carbon material produced by the "one single process" may perhaps meet certain requirements for electric and magnetic purposes, and the product is generally suitable for any purpose where an extremely low percentage of carbon in the iron is desired. After the thorough tests to which both the iron and steel materials produced at Hagfors have been subjected, the author is satisfied that their quality is superior both to the open-hearth and the Bessemer products. While it is true that no scientific investigations have been made into the causes which make such results possible, we are justified in assuming that the superiority of the product of this electric process is due to the relative absence of gases and the small amount of slag. The process works constantly under exclusion of air, and with a slight over-pressure in the furnace.

Blast Furnace Practice in India*

With Special Reference to Economy in Coke Consumption

By J. L. KEENAN†

THERE are at present three modern blast furnace plants in India. The Bengal Iron Company, the first to start operations, and the Indian Iron & Steel Company, are located near Asansol, on the East Indian Railway; the Tata Iron & Steel Company, which started operations in 1911, is situated about 150 miles from Calcutta on the Bengal-Nagpur Railway, two miles from the junction of the Kharkai and Subernareka rivers. The present paper is limited to describing the practice followed at the last mentioned plant.

As both of the above mentioned rivers practically dry up during the months of April and May, sufficient water is pumped during the year to two large basins to insure a steady water supply.

Iron Ore.

The iron ore (haematite) is obtained from three mines in Mayurbhanj State: Gurumahissani (40 miles

blanket of boulders and earth on the hill slopes, and varies from a few inches in thickness up to 18 or 20 feet.

Flux.

Both dolomite and limestone are used, and these also are worked in deposits of pre-Cambrian age in Gangpur State (Behar and Orissa). The chief deposits now worked by the company are at Panposh and near Kansbahal, 106 and 120 miles respectively from the works site, on the main Bengal-Nagpur Railway, but a small amount of limestone is obtained from Baraduar, 250 miles from works site, also on the main Bengal-Nagpur Railway line.

Coal.

Coking coal is obtained from the Jherria coal field (117 miles from works site) from beds of Barakar stage in the Damuda series of the Lower Gondwana system. This corresponds approximately with the

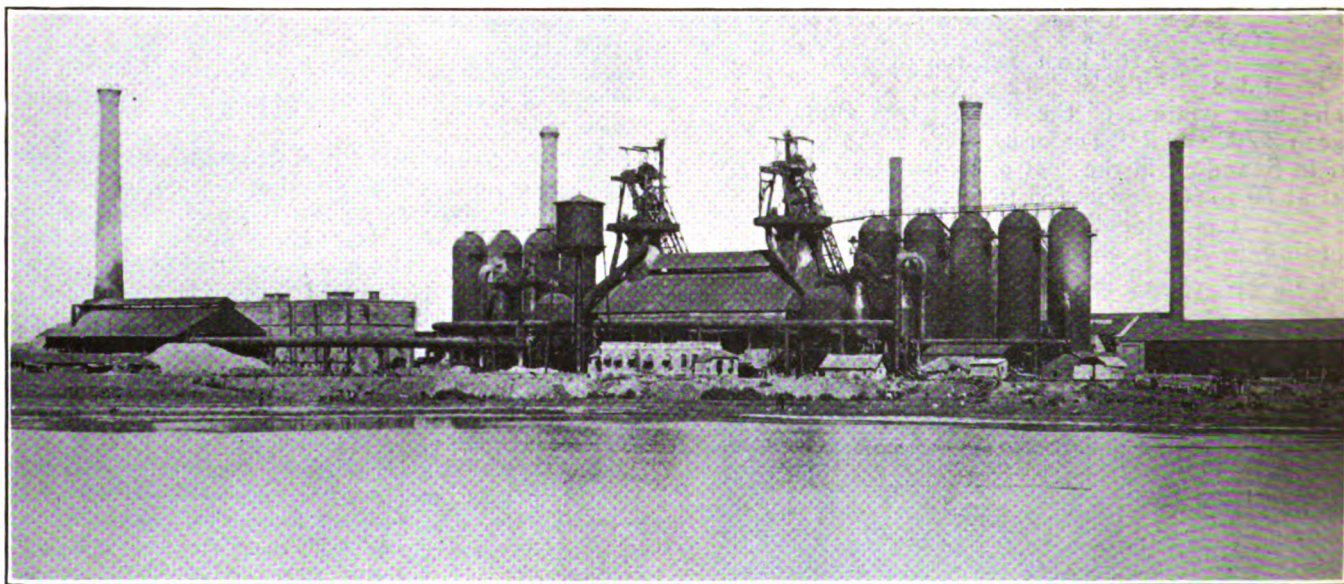


FIG. 1—Bird's eye view of the most modern blast furnace in the Orient. Two furnace plant of the Indian Iron and Steel Company, Ltd., at Asansol, India, about 120 miles northwest of Calcutta. Designed and supervised by American engineers.

from works site), Sulaipat (46 miles), and Badampahar (54 miles). The deposits occur in rocks of pre-Cambrian age, and are replacements of quartzites and shales. Unaltered and partially replaced quartzites and shales occur interbedded with the ores, and the source of the iron appears to be connected with a series of basic dykes which cut through the whole series. The age of replacement may be comparatively recent, geologically speaking.

Up to date none of the ore in situ has been worked. Only boulders and pebbles of float ore broken away from the main ore deposits have been mined. No underground work is necessary. The float forms a

*Presented before the Iron and Steel Institute, London, Eng., September, 1925.

†Blast Furnace Superintendent, Tata Iron & Steel Company, Jamshedpur, India.

Lower Permian. Gas-coals are obtained from the Raniganj stage, a little higher in the Damuda series, with a haulage of 130 to 146 miles to works site. The Raniganj coal field lies to the east of the Jherria field, and both are served by the East Indian Railway.

Plant and Equipment.

The present blast furnace plant consists of five skip-filled furnaces. "A" and "B" furnaces are the original units. They were blown in 1911 and 1912, respectively. They are 77 feet in height. Originally they had 12-foot hearths with a 73° 44' bosh angle, but were enlarged in 1916 to 14 feet 8 inch hearths, with 78° 14' bosh angles. "E" furnace was originally in Battelle, Ala. This furnace was dismantled during the war and re-erected here with the same lines as "A" and "B." It was blown in first in 1919. "C" and "D"

furnaces were blown in in December, 1922, and January, 1924, respectively. These furnaces are identical in construction, being 87 ft. 1 $\frac{7}{8}$ in. high. They have 17-ft. hearths, 21 ft. 6 in. boshes, and 79° 5' bosh angles.

"A" and "B" are equipped with four Kennedy central combustion chamber two-pass stoves having a heating surface of 38,800 square feet. "C" and "D" have four side combustion two-pass stoves with 70,163 square feet of heating surface. Each stove on "C" and "D" is equipped with a waste-heat fan. All the gas for the stoves is washed in wet washers.

Raw materials are brought up a gantry and dumped into up-to-date storage bins. Practically all raw materials are brought in in bottom-dump hoppers. The ore and stone are drawn from chutes into electrically equipped lorry cars. The coke is drawn direct into skips from central bins.

The blast is supplied by two power houses. "A," "B," and "E" furnaces are equipped with three Escher Wyss 35,000 cubic feet capacity and one 37,000 cubic feet Ingersoll Rand turbo-blowers. "C" and "D" furnaces are equipped with four 45,000 cubic feet General Electric turbo-blowers.

The boiler plant consists of 25 Babcock & Wilcox combination gas and coal fired boilers, 20 Wicks gas fired boilers, and eight automatic coal fired Babcock & Wilcox boilers.

"A," "B," and "E" furnaces are equipped with large cast houses with overhead cranes. These furnaces can be run into sand or ladles. "C" and "D" furnaces are equipped for ladle practice only. Any surplus metal above steam mill requirements is poured over the pig machine, which has a capacity of 1,000 tons daily. The hot metal is handled in 60-ton Pollock ladles. Slag is handled in steam dump Pollock cinder ladles and used for filling purposes. All sand-cast iron is broken hot. After cooling it is thrown over the cast-house wall on to breaking blocks and head-loaded by women into wagons.

Analyses and Preparation of Raw Materials.

The coke oven plant consists of 180 Coppée non-recovery ovens (now idle), a battery of 50 Koppers by-product, and three batteries of 50 ovens each of the Wilputte type, a total of 380 ovens. The production capacity is approximately 2,350 tons of coke in 24 hours. The average coke passes through a 4-inch ring. Four per cent of breeze is removed from the coke bins. A fair average analysis of the coke is as follows:

Moisture	Ash	Vol.	S.	Fixed Carbon
5.5	21.4	1.50	0.50	71 per cent

All ore is crushed to pass through a 4-inch ring. The ore is practically all lumps with but a small percentage of fines, except during the rainy season, when this percentage increases slightly. The analyses over a year are as follows:

	SiO ₂	Fe.	P.	Mn.	Al ₂ O ₃
Gorumahisani	4.25	59.59	0.066	0.50	4.04
Badampahar	4.93	56.33	0.093	0.54	4.57
Sulaipat	2.66	65.67	0.065	0.15	1.59

Dolomite and limestone are crushed to pass through a 5-inch ring. Limestone is used on furnaces making

foundry irons and ferro-manganese, while dolomite is used on steel works grades. The average analyses are as follows:

	Al ₂ O ₃		CaO.	MgO.
	Ins.	Res. and Fe ₂ O ₃		
Dolomite	4.37	1.48	29.78	20.31
"A" limestone	6.47	1.37	46.19	4.23
"B" limestone	4.02	1.04	48.80	3.50

Manganese ore is procured from the Central Provinces. The average analysis is as follows:

Mn.	Fe.	SiO ₂	P.
50.6	6.4	7.2	0.09

Furnace Practice.

It is the practice at this plant to take full advantage of the stove heat. Stoves are changed every hour and 15 minutes. The cold by-pass valves are never opened. This means that our only margin of safety is to depend on a reduction of blast volume whenever a furnace starts to go off her grade. Formerly it was the practice to carry a fair heat, say 900 deg. F., and keep some heat in reserve. At that time the furnaces tended to work stiff, the pressure often amounting to 20 to 25 lbs. on the large furnaces, and 16 to 20 lbs. on the smaller ones. Three hundred tons was a big daily production on "A," "B," and "E," while 475 tons was considered a big tonnage on "C" and "D."

By increasing the stove heat and paying particular attention to the rotation of filling, the pressure on all the furnaces was reduced. Within a few weeks it was only necessary occasionally to check a furnace. "A" furnace has not been checked for hanging during the past 13 months. The others make regular pressure charts with an occasional chart which is the exception. "A" and "B" drive faster and easily produce 400 tons of basic, while "C" and "D" produce 560 tons daily. The pressure on "A" and "B" is normal at 11 lbs., on "C" and "D" at 13 to 14 lbs.

There are two main features of interest concerning furnace practice in India:

1. The production of iron economically, using a soft coke of high ash content and high solubility.
2. Fuel economy resulting from changes in furnace lines.

The CO/CO₂ ratio in the gas analysis varies within small limits in producing all grades of iron. The CO content varies from 28 to 30, while the CO₂ varies from 9.5 to 11.5. In general, it has been found that the ratio of 29 to 10 holds good when the furnaces are working normally, irrespective of the coke consumed per ton pig.

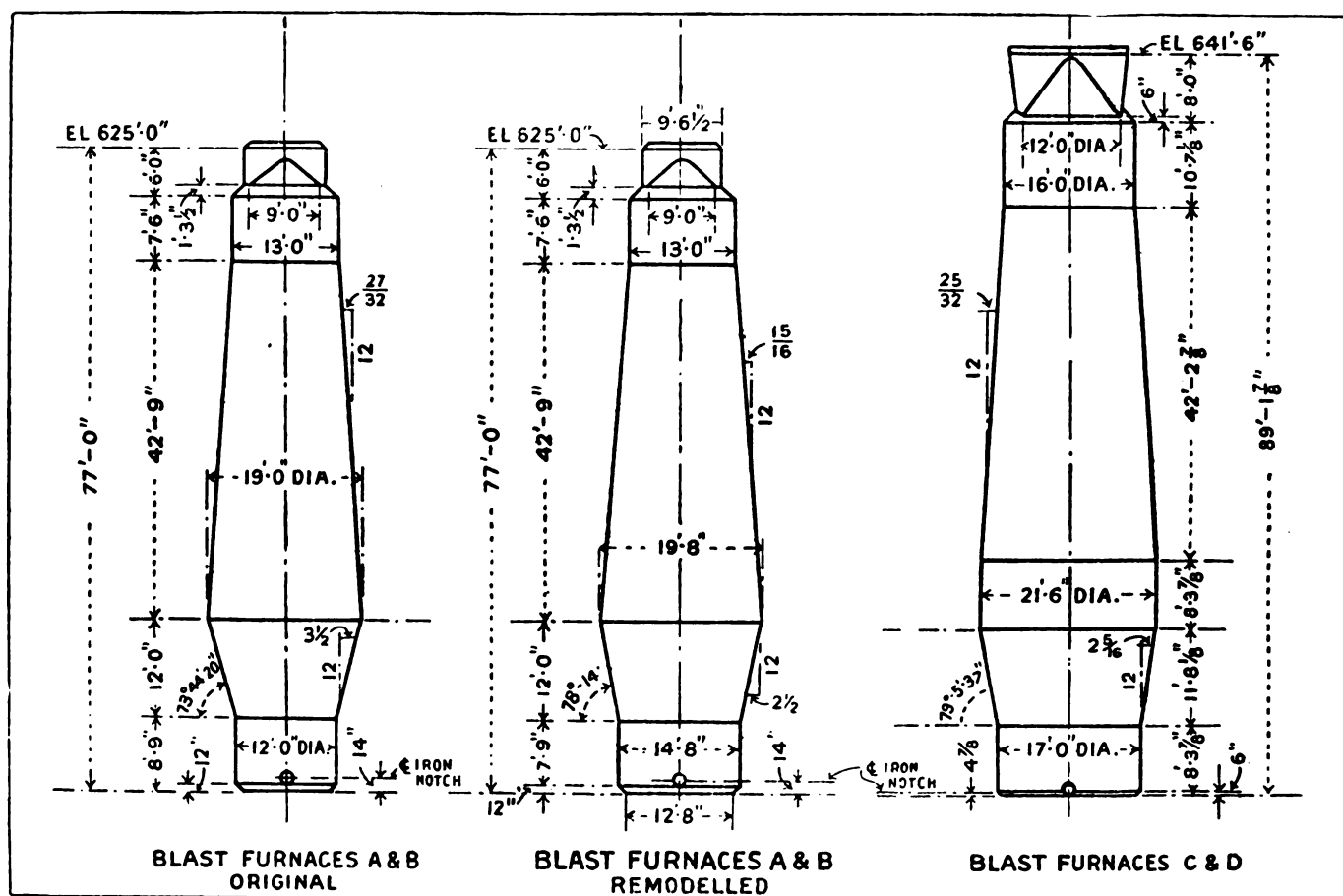
When "D" furnace was blown in during December, 1922, gas was required to burn under the gas fired boilers to supply power for the new mills. It was necessary to curtail the amount of gas necessary to ensure a high stove heat. Often one or two stoves were closed for hours. The result was that the ore to coke ratio was kept down to a point where the furnace would work on the low available blast temperature. The slag was kept on the "limey" side to hold the silicon down. The coke consumption was about 2700 lbs. per ton pig iron. The CO/CO₂ ratio of the gases was 29/10.

After the "C" furnace was blown in and the new coal fired boiler house was put into operation the stoves received their quota of gas. The blast temperatures were immediately increased from 850 deg. F. to 1200 deg. F., and the ore unit was raised from 19,000 to 23,000 lbs., while at times these furnaces, "C" and "D," carried as high as 24,500 lbs. of ore during dry weather. In spite of an increase of 25 per cent of ore the ratio of CO/CO₂ in the gases remained 29/10. The author thinks this illustrates the high solution loss that has to be contended with.

During this period of observation, the carbon dropped from 2042.25 lbs. to 1687.5 lbs. per ton iron, due to higher stove heat, more regular working, smaller slag volume, and a less basic slag. At the same time 58.2 lbs. less carbon reached the tuyeres,

14 ft. 8 in. in diameter, the boshes were 19 ft. 8 in., the angle was steepened to 78° 14', but the height of the bosh was not changed. They now produce 350 to 400 tons of basic iron per day on 2700 lbs. coke per ton pig. Since 1917 the ash content of the coking coal has increased. It is safe to say that the steepening of the bosh and the increase in diameter of the hearth would not have increased the coke consumption had the coke remained of the same quality, the hundred pounds more required today just about offsetting the difference in available carbon.

For some time there was much adverse criticism on the feasibility of building large modern furnaces in India, and the results obtained on our large furnaces were awaited with interest. The argument was put forward that Indian soft coke would not be suit-



due to solution loss in the furnace. Any attempt to increase the ore-coke ratio beyond 24,500:15,000 leads to a cold hearth, with accompanying high sulphur iron and with no noticeable decrease in the CO/CO₂ ratio.

Furnace Lines.

When "A" and "B" furnaces were originally blown in they were 77 feet high (Fig. 1). They had 12-foot hearths, 19-foot boshes. The boshes were 12 feet high. The bosh angle was 73° 44'. They produced 250 tons of basic iron per day, consuming about 2600 lbs. of coke per ton iron. From 1912 to 1916 it was possible to pick and choose the coal required for coking purposes, and it was possible to get a coking coal with about 12 per cent ash content.

These furnaces were enlarged in 1916, the height of both remaining the same. The new hearths were

able for these furnaces. Only a few months ago a directorate in Europe was told that furnaces of the large modern type had not proved their ability from an economic point of view. The author thinks the practice over January and February should allay the fears of even the most skeptical.

"C" and "D" are 80 ft. 1 7/8 in. in height. The diameters of the hearths are 17 ft.; the boshes are 21 ft. 6 in. in diameter and 11 ft. 8 1/8 in. high. The bosh angles are 79° 5'. They have a cubic content of 22,610 cu. ft., against 14,810 cu. ft., the content of the older furnaces.

When the old furnaces were enlarged there was no decrease in fuel required per ton of pig. When the new furnaces came into regular operation there was a decided decrease in fuel consumption. As the blast temperatures are practically the same and the

raw materials similar, the decrease in fuel can only be due to the difference in furnace lines.

As before stated, "A" furnace works smoothly year in and year out. If it were not for the fact that "C" and "D" have proved otherwise, one would readily say that the design of "A" furnace was ideal for Indian coke. Any attempt to raise the ore unit beyond 1.3 ore to 1 of fuel with varying sized burden units was impracticable. Still there is no difficulty in carrying a burden on the large furnaces with the ore to coke ratio 1.6 to 1. The point in question appears to be to explain why the old furnaces failed to produce iron on a lower fuel consumption than when originally built, in the face of the fuel economy resulting on still larger furnaces.

The hearths of "A" and "B" were increased in diameter, their boshes were made steeper, but their boshes were not shortened. After considering the changes from every angle the author is led to believe that the fault lies in the fact that the boshes were not shortened to make allowance for the changes in practice which must take place. In the light of recent research, new theories are being advanced every year, but furnaces are being relined after the model or as close as possible to the lines of the furnace which has proved by practice that it can produce large tonnages on low fuel consumption with a given grade of raw materials.

"C" and "D" furnaces are 69 ft. 1 $\frac{7}{8}$ in. in height. "A" and "B" furnaces are 77 ft. in height. "C" and "D" furnace boshes are 11 ft. $\frac{1}{8}$ in. high, while "A" and "B" have a bosh 12 ft. high. "A" and "B" have higher boshes than the larger furnaces.

	Total Cubic Contents	Bosh Area	Bosh Area Per- centage to Whole
A and B	14,810	2840	19.2
C and D	22,610	3445	15.2
E	15,564	2840	18.25

From these figures it will be seen that the bosh areas on "C" and "D" are much smaller as compared to the whole than the same on the smaller furnaces.

The author submits a diagram of "A" and "B" and "C" and "D" furnaces (Fig. 1).

Assuming that the top of the bosh was situated at the right height for "A," "B," and "E," when they were originally built—i.e., that the descending column of solids started to contract at this point due to fusion—we will now look at the difference after the enlargement of these furnaces.

Larger hearth and tuyere areas demanded more blast to burn the larger area of coke present and to give the proper penetration to ensure smooth working. The greater blast volume lowered the zone of fusion. More stove heat was required, while in turn lowered the zone of fusion, with the result that the descending column of solids reached the top of the bosh before the proper contraction due to fusion took place. The result of this causes one of two things: first, the furnace tends to hang on high pressure; or, second, the descent of the sinking column of stock is retarded sufficiently at the top of the bosh to permit the zone of fusion to rise automatically to the top of the bosh. Both cases demand more coke, especially the second case, where the heat required to do the work on an economical basis in a given area is spread out over a larger area.

If this theory be true—the lowering of the top of the bosh to where the height of the bosh would be comparable to that of the larger furnaces—then the descending column of solids would reach the zone of fusion at the new inverted angle, immediately contracting, and holding the working zone down where it should be. It would then be found that the amount of heat formerly required would be too great for the smaller working area, with the result that the coke requirements could be greatly reduced.

The author will have an opportunity in the near future of observing the saving in fuel resulting from shorter boshes, as one of the old units is at present being relined. Although the bosh is to be shortened, all other lines will be as heretofore. Therefore any saving in fuel will be a direct result of lowering the zone of fusion, due to lowering the top of the bosh. The hearth diameters of furnaces in America were originally increased with larger production in view. The boshes were steepened to conform with the original diameters of the old mantles and that of the new hearths. Larger production resulted, also economy in fuel. The economy in fuel was, the author believes, due entirely to the fact that, as the bosh became more and more perpendicular, the top of the bosh was lowered automatically as the angle became less perceptible.

While theory with regard to reduction in coke consumption, consequent upon lowering the top of the bosh and therefore the zone of fusion, must be a matter of pure conjecture, the author believes that such economy is the result of a more economical production and utilization of carbon monoxide. Whatever the correct theory, however, the main commercial result holds—namely, that by such alteration in furnace lines the coke consumption per ton of pig iron has been lowered by 470 lbs., i.e., a reduction of 17 per cent.

The author desires, in conclusion, to express his hearty thanks to Mr. T. W. Tutwiler and Mr. C. A. Alexander, late and present general managers at Jamshedpur, for the guidance and encouragement which they have always extended to his work. He desires further to record his hearty appreciation of the loyal co-operation of the staff—Indian, British, and American.

American Welding Society

An unusually interesting meeting was held by the Welding Society. Of first importance were the technical sessions, exhibitions and demonstrations, for which the Massachusetts Institute of Technology offered their splendid facilities.

A full social program kept the visitors busy for the three days. Speeches by Mayor Curley of Boston, Dr. S. W. Stratton, President of Massachusetts Tech.; Prof. C. A. Adams, Founder of the American Welding Society; Prof. Elihu Thompson of the General Electric Company and Prof. A. S. Kinsey of Stevens Institute. These speeches were broadcasted.

Program.

Wednesday, October 21 — Morning: "Thermit Welding," J. H. Deppeler, Chief Engineer, Metal & Thermit Corporation. Afternoon: "Gas Welding of Power Plant Piping," A. W. Moulder, Chief Engineer

(Continued on page 448)

SHEET AND TIN PLATE

*Defective Material and Processes**

The Main Object of This Paper Is to Commend the Use of Simple Means of Investigation for Defects Such as Pickling, Etching and Sulphur Printing

By HARRY BREARLEY

WHEN steel was first melted, about 1740, and for one hundred years thereafter, the material available to purchasers was an iron-carbon alloy varying only in the amount of carbon it contained; and to an insignificant extent in other elements of its composition. In due time the steel makers realized that steel could be made harder or softer by varying the kind of material charged into the melting crucible. In those early days the raw material consisted exclusively of carburized bar iron, the resulting cast steel was harder or softer depending upon the extent to which the raw materials were carburized before melting. At a much later date more or less uncarburized iron and charcoal were charged together so that the carburization took place in the crucible during the melting operation.

This practice appears to prove clearly that the different degrees of hardness of the melted steel was due to the different amounts of carbon it contained and this was actually the case. It is by no means certain that any considerable number of the active and successful steel makers realized that the correlated group of physical properties of the steel bore any definite relationship to the carbon content. This direct relationship did not appear and could not appear until chemical analysis became part of steel making routine, which did not occur until after 1860 or 1870.

It would probably be misleading to suggest that the maker of crucible steel was seriously handicapped for want of a chemical laboratory. On the contrary, so long as he was making small ingots, he managed very well without a chemical laboratory. After the ingots were made, their ends were broken off to expose a fractured surface and the breaking or "topping" operation was continued until all trace of pipe material was removed. If the ingot contained blowholes, or showed signs of having been cast from a very high temperature, it was scrapped. This laborious "topping" operation secured what chemical analysis cannot ensure, viz., sound ingot material. It also enabled the observant craftsman to see fractures across the full section of the ingot and to deduce therefrom an impression of the general conditions under which the ingot had been cast; and most important of all to determine from the appearance of the fractured surface the degree of hardness of each ingot and the particular category into which it should be classified for

making this or that kind of tool. As a good steel maker could distinguish from the appearance of fractured surfaces a variation in hardness corresponding to .02 or .03 per cent carbon it may be concluded that this means of observation was developed to an extraordinary extent. A description of how they distinguished the fine shades of difference between fractured surfaces has never appeared in print and probably never will. The most eloquent of such observers would have difficulty in explaining verbally, even with the aid of illustrative examples, how it was done.

This brief sketch of the technology of early steel-making explains why in cases of failures or complaints relating to the use of steel, the steel maker was the

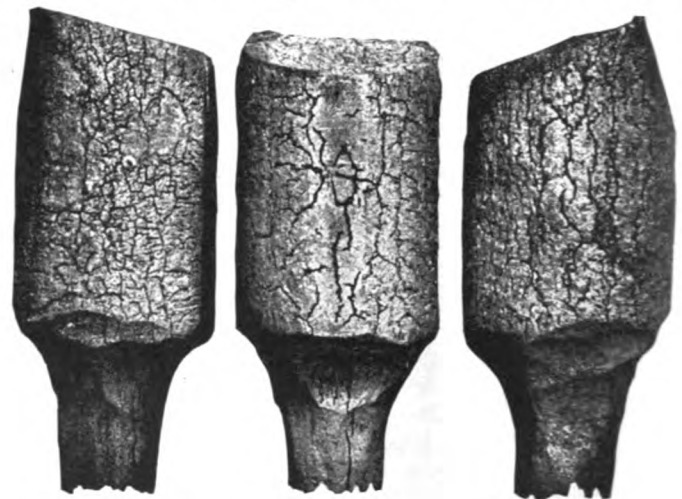


FIG. 1—Crazy cracks in valve forgings revealed by pickling.

judge and jury combined. It may also explain why it became the practice in the steel trade to shoot all complaints back to the steel maker and hold him responsible unless he could clear himself. It was undoubtedly an advantage to both parties in the early days to bring troubles directly to the notice of experienced men trained in the observation of minute differences, who were also in a position to remedy a defect. So far as the available skill would reach, the procedure was directed, instructive and generally produced the desired effect. The procedure was the best possible, within its limitations.

In these later days consideration of defects in materials or processes is not so simple and the balance of capability is not so heavily weighted in favor of the

*Paper read before the Coventry (England) Engineering Society and reprinted from the Journal of the (British) Association of Drop Forgers and Stampers.

steel makers. Conditions are more complex and questions arise of defective materials and processes in relation to structural steels—a class of materials which before the days of the pneumatic chipping hammer received scant attention and were rarely the subject of complaint.

The changed conditions have been brought about by:

1. The introduction of drop forging.
2. The use of high tensile steels for structural purposes.
3. The heat treatment of steel including case-hardening.
4. The use of parts made as light as possible for heavy loads applied continuously or occasionally.

These altered conditions have caused defects in materials and processes to be a subject for constant

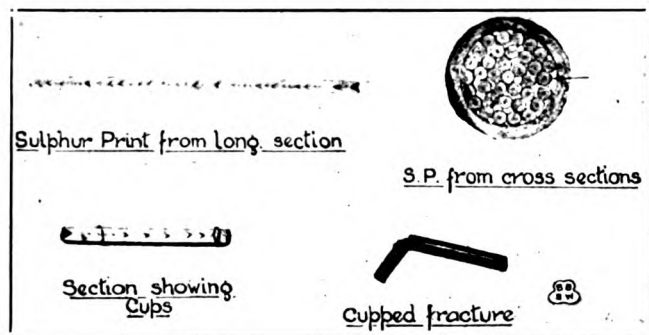


FIG. 2—Composite photograph showing cupped wire due to axial segregates.

supervision; and at times a source of contention not only between the maker and user of materials but also between the departments of the same firm engaged in carrying out a sequence of processes.

The greater number of the questions in dispute might be settled by experience and common sense. It is becoming the custom, however, for steel makers to refer these questions to research laboratories, and the consumers seem to be moving in the same direc-

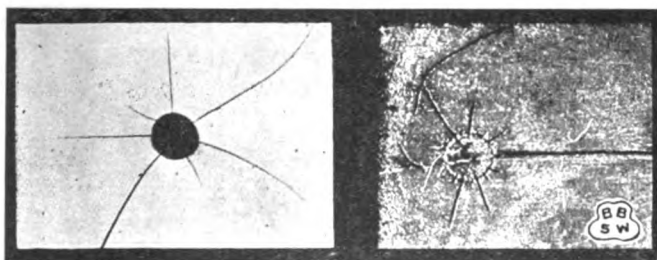


FIG. 3—(Left)—Cracks radiating from Brinell impression on testing hardened steel object. (Right)—Cracks from Brinell impression developed on pickling.

tion. One disadvantage of this procedure is that the evidence to be gathered on the spot by the man who is doing the job may be neglected. Another disadvantage is that the contentions are apt to be exaggerated or degraded to points which can be appreciated only through the microscope while the real point at issue and the remedy may be entirely overlooked.

The value of the material involved in any complaint or dispute should be regarded as a detail, in the initial stages of the investigation at any rate. But if the real

cause of the defect is overlooked and a remedy is not found the contention will recur and both parties will continue to lose in diverse ways. It would seem desirable, therefore, to start by asking where and how does the defect arise. It is folly to agree to a settlement until these questions have been answered. If a decision is forced without investigation both parties deceive themselves though one of them may appear to gain. No trouble is satisfactorily dealt with if the investigation does not lead to a remedy.

It might be helpful in the first place to say what is meant by a defect. The inspector says the slightest roak in a straight shaft is a defect, while he sees no reason against forging an array of figures on the body of the shaft. A shaft which fails to clean up is scrapped whereas similar shafts may go into service in a roughly machined condition. Such an attitude appears to be neither consistent nor reasonable. It may, however, be submitted that a defect, as distinct from a blemish, is defined by three consequences:

1. It makes the material more costly, e.g., more difficult to machine.
2. It makes the material less reliable.
3. It makes the material less durable.

These consequences in many cases merge into each other, but they will serve as distinctions on which to hang a few illustrations.

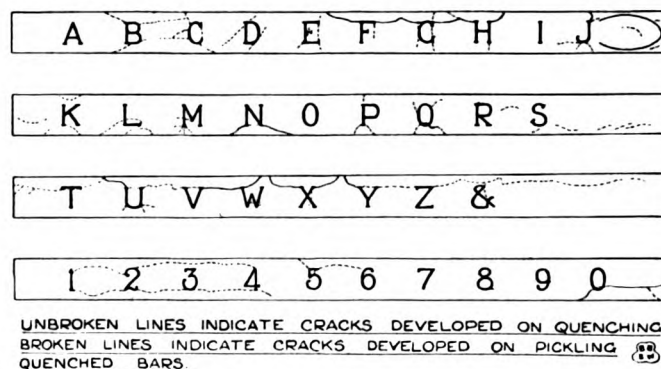


FIG. 4—Cracks from stamp marks on hardened and pickled strips; unbroken lines indicate cracks developed on quenching, broken lines indicate cracks developed on pickling.

The choice of material and the choice of a manufacturing process require considerable thought. Of the materials wrongly chosen none deserve greater prominence than nickel chromium steels. They are difficult to make, expensive, difficult to work and prone to failure in any particular operation on account of their inherent properties. In many circumstances their use is almost indispensable, notably where final air hardening is contemplated and again where a large mass of steel must be heat-treated to give high tensile strengths combined with considerable toughness. It is, however, difficult to understand why the dangers of clinking on reheating and cracking on quenching should be risked by using intensively-hardening nickel chrome steels for small articles which finally will be oil hardened and tempered. Unless the mass effect is predominant equally good results with tensile strengths in the neighborhood of 50 to 60 tons are obtainable from straight nickel steels which are safer, easier to work and cheaper than the nickel chrome steels.

A collateral mistake in the choice of a process may be illustrated by defects arising from the air-hardening

property of some alloy steels. Hardly any workman would venture to forge a piece of ordinary carbon steel and throw it while red hot into water. He would not be surprised if it cracked. If then it were rashly reheated and again quenched he would expect it to crack. Yet something like this procedure is occasionally followed with intensively air-hardening steel. If the steel does not crack the finished forging may be no worse for its drastic treatment; but if it should crack or if some pieces crack and others do not it would be unreasonable to express surprise.

Some air hardening steel bars intended for valve making were first cut into slugs and after cooling they were naturally hard. They were reheated to swage down the stem and again allowed to cool. They were finally reheated to up-end the valve head but many of them opened out at this stage. It happens sometimes, as in this case, that the cracks are numerous and superficial. They may not be easily detected by examining the scaled bar. But they are easily visible

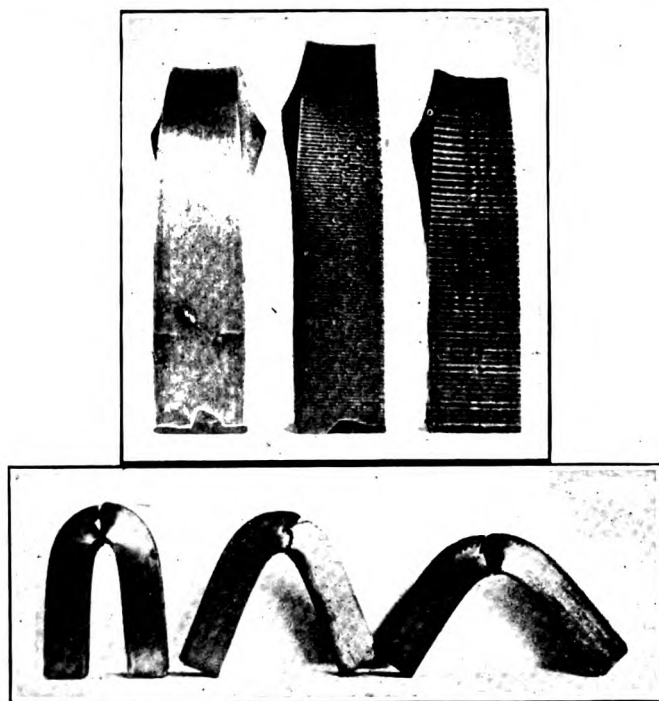


FIG. 5—Cracks on roughly machined surface. ($\times 15$.)

after pickling whether they be single cracks originating from a sheared end or crazy cracks forming the dainty pattern seen in Fig. 1. Such defects as make material less reliable in service are usually hidden defects. They may even arise from precautions taken to avoid defects.

It sometimes happens that the precautions intended to increase the reliability of an article actually decreases its reliability. A Brinell impression, for example, made on a hardened steel object in order to prove its fitness is always a potential defect. In rare cases the crack appears at once (Fig. 3), but in most cases it can be made to appear by pickling. During pickling the evolved hydrogen is absorbed by the steel. This increases the brittleness of the steel and causes the stress in and about the Brinell impression to form radiating cracks as seen in Fig. 3.

Similarly, stamp marks used for identification purposes may cause cracks. Whether the stamping is

done "hot" or "cold" hardening stresses will reach an abnormal intensity about the lettering. There may finally be an obvious connection between the identification mark and the failure, or a connection apparently so remote that its existence is questionable. Whether the article has to be hardened or not the position of the stamped identification mark and the design of the lettering used are worth consideration. Some letters are safer to use than others. As a matter of interest the alphabet and the numerals were impressed cold on strips of .9 per cent carbon steel. The impressions were made with a Brinell machine using a load of 5,000 kilos. The strips $\frac{1}{4}$ in. by $\frac{3}{4}$ in. were then quenched in water from a uniform temperature of 760 deg. C. The cracks which originated are shown as unbroken lines in Fig. 4. The strips were then pickled, and the cracks which formed are shown in Fig. 4.

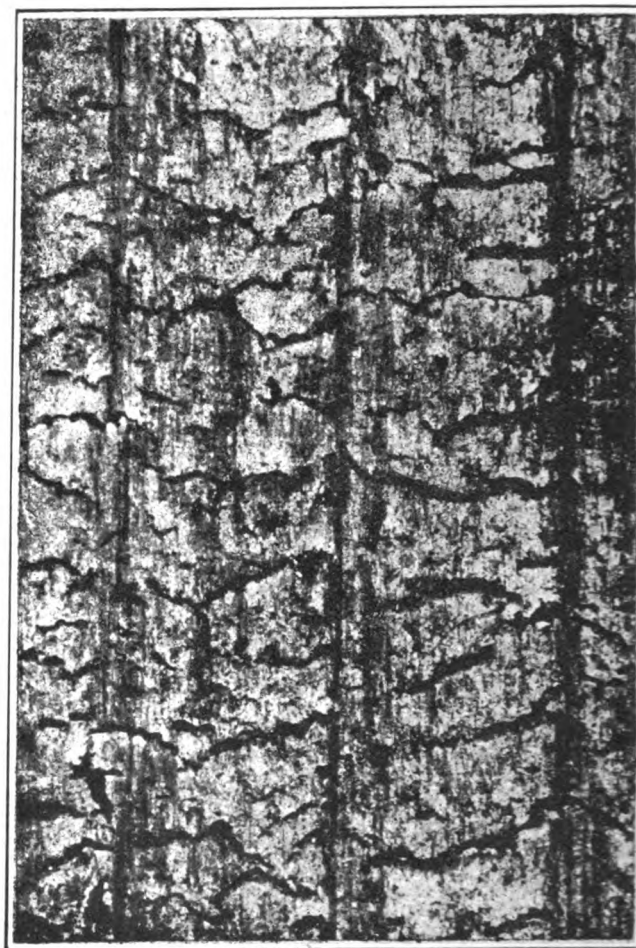


FIG. 6—Bending tests showing effect of degree of rough machining.

Articles are frequently machined in order to remove surface imperfections. The intention is excellent but the results are often disastrous. Very few surface imperfections are so deceptive as those concealed in a roughly machined surface. It seems so much a matter of course that after machining the surface should be free from defects. As a matter of fact, a roughly machined surface is full of defects which lead to many failures.

A rough-turned bar direct from the lathe is really a kind of threaded bolt; the depth and pitch of the

thread being depended on the cut and feed used in the turning operation. A lathe tool, moreover, does not cut in the sense that a razor or a surgeon's knife cuts. On examination the turnings are seen to consist of small pieces sheared one up against the other. The turnings can be crumbled under light pressure along the shear planes. It is proper, therefore, to regard a turned axle for example, as a surface from which greater or lesser pieces of steel have been sheared or torn away. If the skin of a rough-turned axle could be peeled off, say to the depth of one millimetre, it would be brittle however tough the undistorted material itself might be.

Along the groove left by a turning or shaping tool may be observed the periodic occurrence of small cracks or gaps lying at right angles to the direction in which the work has moved past the tool (in turning) or the tool has moved over the work (in shaping) as indicated in Fig. 5. These small gaps are caused by the edge of the tool pushing the layer of steel before it until such time as the steel can move no further without breaking. At the spot where the steel, distorted by the moving tool, thus breaks, one of the small gaps is formed. This accounts for the gaps being periodic; the size and spacing of them depends on the cut and feed. On a turned axle the gaps lie along the axle and across the direction in which the axle will be stressed in service; they may not, therefore, do much harm. It is easy, however, to see that the gaps in other objects may lie in a direction which under service conditions would facilitate the extension of the gap into a serious crack or a complete fracture.

An example of the general effect of rough-machined surface is shown in Fig. 6, which represents bent test pieces made from the same bar but finished with different degrees of smoothness. The depth of groove, amount of distortion, and intensity of gaps on the surface decrease from right to left. When deflected under a hydraulic press the bars broke after bending through angles which vary according to the condition of the machined surface. These tests show the advisability of grinding the machined surfaces of highly stressed structural parts. The grinding allowance should be sufficient to remove not only the peaks of the grooves, but also to thoroughly bottom the gaps or tears and the distorted surface. Smoothly ground surfaces as compared with roughly ground surfaces are also important. Rough grinding on a coarse-grained wheel can produce considerable surface distortion and also other evil effects. In this respect rough grinding is hardly preferable to finished turning.

Non-Destructive Test for Wire Rope

A test which could be applied to steel hoisting rope to show whether it is in safe condition or not, and which would not require the cutting of a sample from the rope, would be of great value. Every industry and operation which depends on wire rope for hoisting and haulage purposes is anxious to learn of some method by which the condition of ropes can be determined in service.

For some time the Bureau of Standards, Department of Commerce, has been investigating the possibility of applying some form of magnetic test to wire rope to determine its condition, as it is known

that breaks in the individual wires, worn places, etc., as well as the stress of the rope, affect its magnetic permeability. The development of any practicable test is a difficult matter, because of the many variables which must be considered.

In order to design intelligently apparatus for the non-destructive testing of wire rope it is necessary to know the nature and magnitude of the effects involved. One of the causes of deterioration of rope is wear, and the Bureau has recently completed an investigation of the effect of wear on the magnetic properties and tensile strength of steel wire such as is used in the manufacture of wire rope.

The Bureau found that wear increases the magnetic permeability for low magnetizing force, and decreases it for higher values; in other words, opposite readings are secured, depending on the magnetizing force employed. A load on the wire produces a similar effect, though it is much less in magnitude, and is probably caused by a redistribution of the internal stress in the wire. This change in magnetic properties is accompanied by an increase in the tensile strength.

The complete results of this investigation are given in Scientific Paper No. 510 of the Bureau of Standards, copies of which can be obtained from the Superintendent of Documents, Government Printing Office, Washington, D. C., at five cents each.

Testing Automobile Steels by Sparks

A novel method of inspecting automobile steels to determine quickly the chemical composition is the spark test, which, although by no means new, has only recently been adopted as a routine method of inspection in large scale production in the Buick plant, said J. C. Ross, general superintendent of the Buick Motor Company, in an address at the production meeting of the Society of Automotive Engineers in Cleveland recently.

The spark test depends on the fact that minute quantities of certain elements in steel alter the appearance of the sparks emitted when the material is ground on an abrasive wheel. It is performed with a small portable grinding machine that can be carried from place to place and plugged into a light-socket by a long cord. A binful of stock can be sparked on the ends of the bars without removing or handling the material.

Carbon, the most important element in steel, excepting iron, has a very pronounced influence on the spark. In testing medium and low-carbon steels by this method, the carbon can be determined within 2/100th or 3/100th per cent by using a suitable standard of known carbon content. Nickel in steel also gives a characteristic spark, as do chromium, tungsten and vanadium. One-half of 1 per cent of nickel can be readily detected, which allows easy differentiation to be made between standard steels.

In sorting mixed stock, the spark test is of great help. Individual bars can be rapidly and cheaply "sparked" and placed in their proper classifications. In the Buick plant, all piston-pin tubing stock is spark tested as a routine method of inspection. Stock for certain other parts, such as shackle bolts, is handled in the same way. It is essential that the cores of these parts, which are case hardened, should have a carbon content of not more than $\frac{1}{4}$ of 1 per cent, for a higher carbon induces brittleness.

Low Temperature Carbonization in Revolving Retorts

By A. THAU*

NEARLY 17 years have elapsed since low temperature carbonization of coal was taken up as a technical and commercial proposition when Parker in England took out his first master patent which formed the foundation of the Coalite process. There is in all probability no other technical process in existence which has, without yielding a complete success, taken so much time for its development occupied by a multitude of trials, at the same time swallowing many millions of money with a so far rather scanty return. To look at, the problem seems so simple because in gas works and coke ovens coal is carbonized at a temperature of about 900 deg. C. without the slightest difficulty. Should it be so difficult to do the same thing at a few hundred degrees less? Efforts to answer this question by a practicable demonstration of a workable plant have turned many an enthusiastic engineer into a pessimist and are responsible for the expenditure of huge capitals.

If the difficulties accompanying low temperature carbonization are analyzed, they can be summed up as resting with the heat resisting property and small heat conductivity of the coal which makes it imperative to treat coal either in comparatively thin layers or in continuous motion. Carbonizing in thin layers means a small output in proportion to the area of the heated retort surface and requires thus a great number of units for carbonizing a given tonnage, at the same time requiring much labor for the intermittent method of operating. Carbonizing the coal in motion is always carried out by continuous operation, but if it is already difficult to obtain a fairly hard coke in intermittent low temperature carbonization and only possible with coal of a high agglutinating capacity, in continuous operation, the formation of coke at the

applied temperatures is made nearly impossible, or if large lumps of coke are formed they cause an obstruction of the mechanically driven coke discharge and upset the whole operation.

Low temperature carbonization has been developed in the three main coal producing countries, viz., England, America and Germany. A description of the numerous methods suggested and tried in these countries would fill a huge volume of interesting reading. Suffice to say that in England the Coalite process is the only one carbonizing coal at low temperature in intermittently operated vertical retorts on a small commercial scale. No further plant has been built beyond the one working at Barnsley in Yorkshire. In the United States the Carbo-coal process was developed at Irvington with such promising results, that the largest low temperature carbonization plant in the world was subsequently erected at Clinchfield and aroused general interest as a novel solution of the difficult problem. After not quite two years of operation this plant also was shut down again on account of its high upkeep, and anyone who believes that low temperature carbonization is, even from a technical aspect, a solved problem is advised to read the frank reports of Curtis and Chapman* to whom much credit is due in having stated the facts so openly and fully dwelled upon the many difficulties which are still to be overcome before the low temperature carbonization plant can be considered a standard process.

The fact that the low temperature carbonization process has been developed and tried by so many different ways and means, that from a mechanical and chemical point of view there can hardly be a new design or apparatus which has not had a closely related predecessor, sounds rather suspicious inasmuch as for the carbonization at higher temperatures in

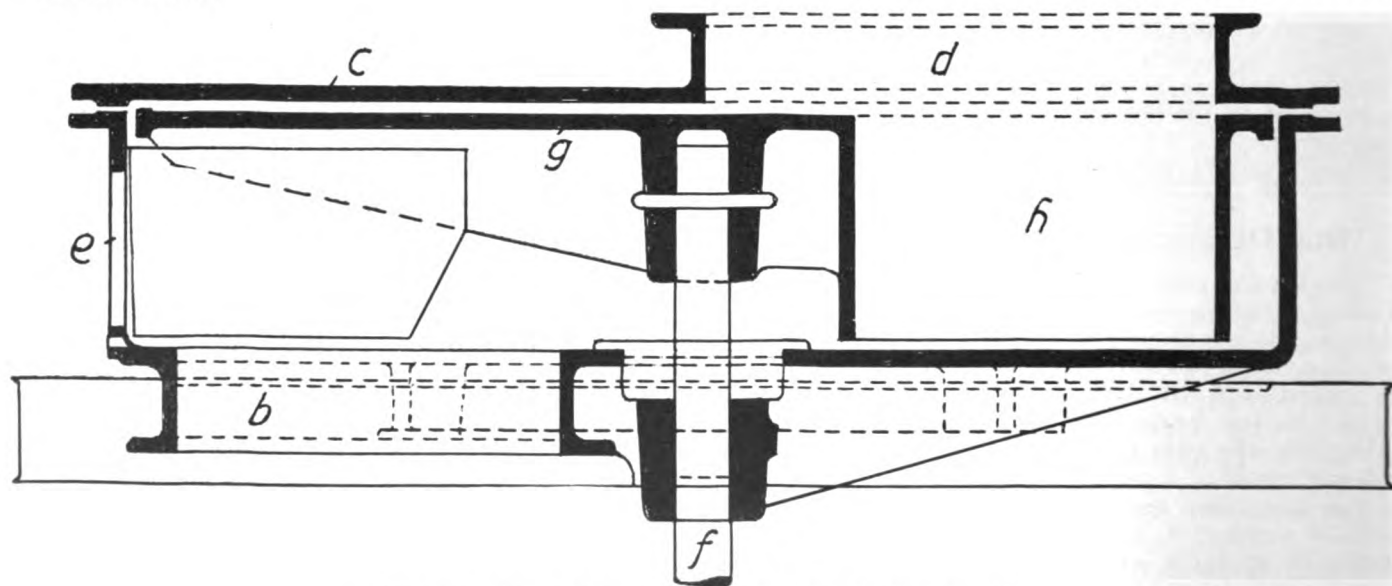


FIG. 1—Coke discharge section of retort, showing details.

*Halle, Germany.

coke ovens and gas retorts standard apparatus is applied throughout the whole world.

Owing to lack of coal high in volatile matter, low temperature carbonization was not taken up in Germany, until war conditions with their acute scarcity of oil compelled trials in this direction. Though the German patent literature is full of designs of low temperature carbonizing retorts, it is rather strange that only the revolving retort has been applied on an industrial scale, while of trials with retorts of other construction nothing has become known. The reason for applying just a revolving retort for this purpose is not far to seek because Prof. Franz Fischer, chief of the coal research institute at Mülheim-Ruhr, happened to make his test trials with such an apparatus having a capacity of about 30 lbs. of coal. As the revolving furnace was a well known and frequently applied device in the iron and cement industry, there was already at hand a wide and varied experience in its construction and operation so that only small alterations were required to make the design suitable for the low temperature carbonization of coal. In the first place, the furnace had to be made gas tight on

while a report of the other types will follow after sufficient facts are available to enable a just conclusion to be drawn as to their operation.

The retort is constructed by the engineering works of Fellner and Ziegler at Frankfurt-Main, being designed by Dr. N. Young, and is erected and in operation at the blast furnace works at Gelsenkirchen in Westphalia. The run of mine coal arriving in railway cars is unloaded by means of grip buckets into the storage bin and runs from this over a mechanically operated feeding arrangement into the roller crusher. The latter, together with the feeding arrangement is driven by an electric motor and the crushing rolls, being held in position by spiral side springs to allow for any iron parts which may be mixed with the coal, deliver the coal at a maximum size of about 1 in. The crushed coal drops into the small hopper feeding the vertical bucket elevator and delivering on top of the coal hopper into the spout. The coal runs by gravity from this spout into the cylindrical coal hopper riveted together of steel plates, having a capacity of 20 tons and being tapered towards its bottom outlet. The latter is connected to the mechan-

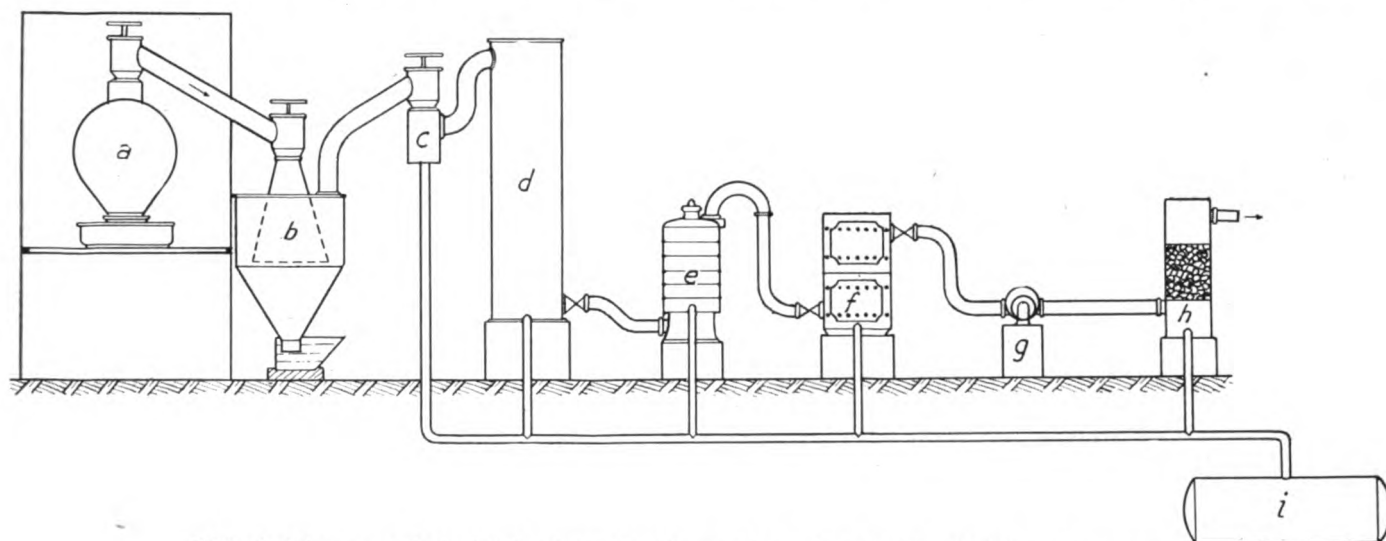


FIG. 2—Diagrammatic sketch of gas handling equipments, indicating the flow sequences.

both ends and arrangements had to be added to ensure a continuous charging and discharging under the exclusion of air. This was soon accomplished and two plants were erected independently on the makers' engineering works on a semi-commercial scale solely for trial purposes. The results were so promising that in 1919 orders from the coal mining and iron industry were received to build such plants on a commercial scale. Altogether there are in Germany five such plants, of which three are at work and two are still under construction. There are three different makers each with a different design of revolving retort.

Also in the United States a revolving retort for low temperature carbonization of coal is operated in the Pittsburgh district, but no details or reports have been published as yet. All the more it may be of interest to the American engineers concerned, to hear of the results of a low temperature carbonization plant in Germany after its first year of operation. In the following report it is intended to deal only with one of the three designs of revolving retorts which have been developed in Germany and with which the writer was particularly acquainted as superintendent,

ically operated feeding device which can be adjusted very closely, regulating the amount of coal continually delivered to the revolving retort. The coal slides through the cast iron connecting pipe of square section and arranged on a steep angle into the revolving retort.

The retort is riveted together of mild steel plates of special heat resisting material 18 mm. (11/16 in.) thick. It is 20 m. (65 ft.) long and has an internal diameter of 2.5 m. (8 ft.). The drum rests with two heavy cast rings upon heavy carriages with rollers, being erected upon heavy concrete foundations so that the retort is supported in an inclined position, the drop amounting to about 5 per cent, so that the difference between feed and discharge end of the retort equals approximately 1 m. (39 in.). To allow for a free movement of the cylinder during contraction and expansion the rings as well as the rollers have plain machined outer surfaces without flanges or rims, and to a sliding of the cylinder towards its lower end, a guide roll is provided behind the upper ring, being held by a strong vertical bearing resting in a bracket which is bolted to the concrete foundation with heavy bars.

On the extreme feeding end of the drum a heavy tooth ring is bolted to the cylinder, being in gear with a double gear wheel drive which is influenced by a belt from the main electric motor and counter shaft supported upon the iron construction of the coal hopper building. A stationary casting bolted to the connecting piece and tightening by means of labyrinth joints into the end plate of the cylinder forms the connecting link between hopper, feeder, inclined feeding tube and revolving retort.

On the lower discharge end of the retort the drum projects by labyrinth joints gas tight into a stationary cast iron housing resting upon the coke discharging arrangement. The latter consists of a vertical shaft driven by gear wheels from a separate electric motor. On its upper end is keyed to the shaft a circular cast iron plate into which is cast in one place close to its periphery a piece of pipe of 600 mm. (24 in.) diameter and just long enough to move around inside the housing of the coke discharge in a vertical position.

The coke discharge being the most important part of such a retort, it is, to make its construction easier understood, separately shown in Fig. 1 in section and consists of a low-cylindrical cast iron housing a with the opening b in its bottom. To the projecting flange of the opening is connected a double valved chamber discharging the coke onto a jiggling conveyor. On the side opposite to the opening b in Fig. 1 the lid c of the housing a is provided with a similar opening d, for receiving the coke leaving the retort. The opening d forms a flange bolted to the lower end of the header of the retort. On the discharge side of the housing a is provided a man hole e closed by a plate bolted to it, serving for cleaning purposes. The vertical shaft f entering the housing a by a tight fitting sleeve bearing carries on its upper end the circular cast iron plate g which is strengthened by thick vertical ribs underneath and in diameter fits exactly inside the housing a so that a gas tight t is maintained. In one place close to its periphery the disc g forms a short piece of pipe h corresponding in height exactly to the inside of the housing a. By the shaft f revolving, the disc is turned about 4 revs. per min. The coke drops from the retort by means of the opening d into the pipe h as long as the latter passes the header, as soon as it moves on its way round over the opening b the coke slides into the pocket without any escape of gas.

The connecting piece in the end plate of the retort has a central opening receiving by means of a gland a shaft which, supported by central hangers, projects about 7 m. (23 ft.) centrally into the retort. To this shaft are fixed horizontally suspended angle iron arms reaching sideways close to the inner surface of the retort shell. The shaft does not revolve, but, being fixed on its extreme outer end to a square tooth rack which is connected to a mechanically operated reversing gear, the shaft is continually and slowly moved forward and backward giving a scraping effect to remove any plastic coal which may stick to the shell and divide up any large lumps which may be formed when operating with an easily baking coal.

The retort makes one revolution in 3 min. 25. sec. and is surrounded by a heating furnace from which it projects about 1 m. (39 in.) on each end so that a length of 18 m. (59 ft.) is heated. The furnace forms at right angle to the retort five combustion chambers into which project the burners. The sixth chamber nearest to the discharge end of the retort is not heated

and connected by means of a flue to the chimney. In the plant at Gelsenkirchen the burners receive blast furnace gas by means of the delivery pipe. The arches of the combustion chamber consist, on the side towards the burners up to the centre of the oven, of solid fire brick work while the other half of the arches from the centre to the side of the furnace opposite to the burners is built of checker brick work to allow the combustion products of the burner flames to pass upwards into the chambers surrounding the retort. This arrangement is made to prevent the tips of the flames from touching and overheating the retort which is thus completely protected from direct heat. The upper chambers are connected to each other by inclined side channels so that the radiant gas is forced to make a spiral way round the retort through the furnace until it leaves by the chimney flue of the last chamber so that the retort is surrounded by a zone of gas of almost even temperature in every place over its whole length and circumference.

To maintain this, the burner receives the greatest quantity of gas because the coal arriving here inside the retort still contains its pit water which must be evaporated, for which additional heat is required. To enable a rapid ventilation of the furnace in case of a sudden stoppage or for repairing, the upper chambers surrounding the retort, are provided on the side opposite to the burners with circular sliding doors which can be opened instantly by means of levers attached to them. To the closed feeding spout is connected by means of a valve a vent pipe carried right up to the roof of the hopper building for the escape of gas from the inside of the retort in case of the gas exhauster being stopped.

Above the burners, level with the centre of the retort sight holes with covers are provided to control the temperature by inspection. Between the arches of the combustion chambers and the bottom of the retort cylinder a thermocouple is placed above each chamber and connected to a switch index graduated in deg. C. so that the temperature in the warmest places of each upper chamber can be determined instantly. The firing is adjusted so that a temperature of 600 deg. C. (1112 deg. F.) is continually maintained and as the resistance of the retort shell diminishes the temperature by approximately 100 deg. C. (212 deg. F.) the distilling temperature inside the retort equals about 500 deg. C. (932 deg. F.).

The top of the header carries two mushroom valves conducting the gas through connecting pipes to the dust catchers. Only one valve, one connecting pipe and one dust catcher are in use at the same time, the second unit being kept in readiness for changing over when the deposit of dust decreases the gas passages too much. The units in which the dust is deposited are changed and cleaned after about 3-5 shifts (8 hrs.) of continuous operation, depending upon the coal carbonized and the throughput of the retort at the time.

The plant in which the gas is treated is shown in the diagrammatical sketch Fig. 2 in which a represents the discharging header of the retort delivering its gas into the dust catcher b. The depositing of the dust in this apparatus is accomplished solely by the reduction of the gas velocity, no mechanical effects like friction or concussion being applied. The inlet pipe broadens inside the dust catcher to a bell and the gas upon leaving the bell deposits its dust with

small amounts of condensed tar upon the tapered shell of the apparatus and ascends, leaving by two outlet pipes which join in the collecting box c. From the latter the gas enters the cylindrical air condenser d and then the centrifugal washer e where the tar is removed completely. In the water cooler f with horizontal water tubes, the water vapors mixed with the gas are condensed and the gas now enters the exhauster g which presses it through the small tower h, the ring packing of which is continually flushed with tar to provide a wet absorption surface. The vapors condensed in the whole plant run through syphons connected by a common drain pipe into the collecting tank i where tar and water form an emulsion which cannot be separated without special treatment. The tower h is not required in the ordinary run of operation and only included to provide a certain safety should the tar not be completely deposited in the washer e or the condensers.

The gas leaving the tower h at a temperature of 15-20 deg. C. (59-68 deg. F.) now enters the gasoline extracting plant, shown on page 440. It is washed with tar oil in two towers connected in series and filled with wooden packing. The scrubbers are 11.2 m. (37 ft.) high and have a diameter of 1.3 m. (51 in.). The intention of the writer to feed the scrubbers with low temperature tar for the absorption of the gasoline vapors and which by its complete absence of naphthalene seemed to be preferable to tar oil, was not workable since the viscosity of the low temperature tar is too high at the low temperatures favoring the gasoline absorption. Until sufficient quantities of distilled low temperature tar are available which, after the pitch residue is extracted, forms an ideal gas washing medium, oil from coke oven tar had to be used which had the great disadvantage of carrying appreciable quantities of naphthalene into the plant which is very difficult to remove since naphthalene is not soluble in gasoline.

The wash oil contained in the tank is circulated by means of the pump over the second scrubber into which the gas enters from below. The oil leaving the scrubber is collected in a tank and by means of a pump circulated in similar manner over the first scrubber which it leaves at the bottom enriched with gasoline and being collected in a tank. From the latter the oil is circulated by another pump to the distilling plant and conducted through heat exchanger with vertical tubes through which pass the vapors leaving the still, while the entering oil surrounds them. The oil leaving the heat exchanger warmed, passes now through the heater in which it is heated by means of a large spiral pipe coil through which passes superheated steam at high pressure. The heated oil then enters on top of the still being of the usual column type in which the gasoline is driven off by means of direct steam introduced at the bottom of the still. The vapors leaving the still pass through the heat exchanger and then through the tubular water cooler and are collected in the separator in which light oil and water are separated on account of their different specific gravity and are overflowing continually. The light oil so produced is collected in a tank. The spent oil leaving the still at a temperature of about 110 deg. C. (230 deg. F.) runs through the serpentine cooler which is cooled by water sprays, back into the first oil tank thus completing and closing the oil circuit of the plant.

As already mentioned, the low temperature tar collected in the by-product plant does not separate easily from the water with which it is mixed and forms a more or less emulsion depending upon the amount of free carbon (dust) contained in the tar. In this respect it differs from coke oven or gas works tar which settles distinctly below the water so that the water can be decanted off without difficulty. The emulsion consisting of low temperature tar and water is easiest separated by applying heat to evaporate the water, but such high temperatures have to be applied for this purpose that also part of the light oil contained in the tar is driven off. For this reason the tar dehydrating plant was united with the gasoline plant and placed in the same building. By means of the pump the emulsion is drawn from the tank and circulated through the heat exchanger and enters the

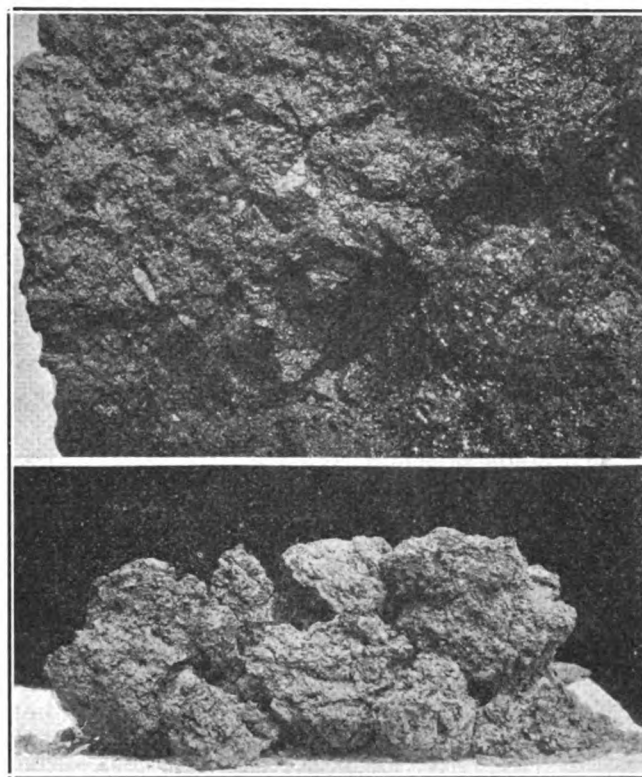


FIG. 3—Samples of semi-coke, the upper natural size; the lower quarter size.

dehydrator which the tar leaves at the bottom practically free of water with a temperature of 110-120 deg. C. (230-248 deg. F.) being collected in the storage tank. The vapors driven off by the dehydrator pass through the heat exchanger, then through the water cooler and collect in the separator where light oil and water are separated and overflowing continually, the former being conducted to the light oil collecting tank. The dehydrator consists of a comparatively small vertical box riveted together of steel plates containing a number of pipe coils with large heating surface through which passes superheated steam at high pressure. A number of fractioning sections are erected on top of the dehydrator box for fractionating the vapors and preventing any tar from being carried over with the vapors. The dehydrator operates continuously as long as there is sufficient tar available for dehydrating.

As the light oil collected in the tank still contains parts of oil or tar of higher boiling point, it must be redistilled. For this purpose an intermittently working still with fractionating column and dephlegmator on top is provided and when sufficient light oil is collected, it is transferred to the still, distilled first with indirect and afterwards with directly introduced steam. The gasoline vapors driven off are rectified in the column, dephlegmated, condensed in a tubular water cooler and collect then in a separator to be transferred in separate fractions according to their boiling point to a number of storage tanks. The residue remaining in the still consists mainly of wash oil and is conducted to the pans and after cooling again introduced into the wash oil circuit.

TABLE I

Daily output of plant.

Throughput.....	54 tons run of mine coal
Semi-coke.....	41.6 tons = 77.04%
Gas.....	5,945 cu. m. = 110 cu. m. per ton (209,858 cu. ft. = 3,883 cu. ft per ton)
Tar.....	3.74 tons = 6.46%
Pitch.....	0.425 tons = 0.78%
Gasoline.....	.853 kg. (18,766 lb.) = 1.58%

The main product is the semi-coke which is quenched, dried and ground in mills and used in industrial furnaces for dust firing. In separating the coke by means of a coke grip with 30 mm. (1¼ in.) distance of the prongs, 42.6 per cent of lumps can be recovered while 57.40 per cent remain in form of breeze and dust. The unclassified coke weighs 610 kg. per cu. m. (38 lb. p cu. ft.) the lumps only 248 kg. per cu. m. (15 lb. per cu. ft.).

Such lumps of semi-coke have been picked out and photographed in Fig. 3 being one-quarter of the natural size. This coke is very soft and can be disintegrated by hand without great effort. The larger pieces have no particular shape, but owing to the rotating of the retort an absence of sharp edges is evident. Compared with metallurgical coke the semi-coke does not show an open cell structure. Hardly any pores can be observed in the surface reproduction of Fig. 3 being of natural size. Run of mine coal being used and only being broken to about 1 in. in size, impurities of rather large size can be noted on the coke surface. All these conditions make it impossible to use the coke for any metallurgical purposes with the exception of gasifying it in producers or grinding it for coal dust firing. A briquetting of the semi-coke is not a paying proposition as a rule.

TABLE II

Analyses of coal, semi-coke and dust.

	Coal	Semi-coke	Dust
	%	%	%
Moisture	5.94	7.36	12.77
Volatile matter	28.80	9.74	15.42
Ash	15.08	17.48	16.18
Fixed carbon	50.18	65.42	55.63
	100.00	100.00	100.00
Sulphur	1.98	1.95	1.92
Hydrogen	3.45	2.67	....
Net calorific value.....	6,338	6,292	....
	(11,408 Btu.)	(11,326 Btu.)	

The low temperature tar condensing in the by-product plant has the usual properties well known to this kind of tar. The results of a number of tests made with average samples are given in the Table

III and it will be noted that its calorific value exceeds that of ordinary coke oven tar which averages 8,500 cal. (15,300 Btu.). The contents of free carbon* with 3.5 per cent must be considered low and speak of a good effect of the dust catchers.

The dust deposited in the dust catchers combines with tar of high boiling point which condenses upon the inner surfaces of the dust catcher shell and forms a soft pitch which is removed on the bottom through a water seal. This product appears under the name of pitch in the Tables I and III. This pitch can either be distilled in a tar still or can be carbonized in a retort, yielding a coke with less than 4 per cent of ash suitable as raw material for the manufacture of carbon electrodes. Compared with the soft pitch in coke oven operation, the low temperature pitch is free from ammonium chloride and does not affect the shell of the tar still. To reduce the output of the rather undesirable pitch which is difficult and expensive to handle, it is proposed to give the dust catcher which is now insulated by a heat protecting coating a jacket and conduct either exhaust steam or hot waste gases from the chimney flue through the jacket space to prevent the tar from condensing upon the dust catcher shell as much as possible.

The physical properties of the light oil and motor spirit produced are shown in the Table IV; the chemical properties are the object of close research work at present. The motor spirit resembles in its composition only slightly the gasoline obtained from mineral oils by distillation but by proper treatment it can take its place almost for every purpose. By treating the re-distilled light oil with sulphuric acid similarly to washing benzene about 60 per cent of the treated volume are polymerized and lost, hence is such treatment hardly a paying proposition. There is no need to wash the light oil with acid for use in internal combustion engines for motor cars but it suffices to wash the light oil with caustic soda lye to remove the sulphuretted hydrogen which it holds in solution. Besides removing the sulphur that way, the caustic soda combines with the phenols contained in the light oil and is worked up afterwards to manufacture pure carbolic acid and valuable cresylic acids by the usual well known methods. This is commercially a good proposition, paying completely for the washing process and leaving a good margin as profits. The yield equals about 1 kg. (2.2 lb.) of pure carbolic acid per ton of coal carbonized.

After being treated with caustic soda lye, the light oil is washed repeatedly with water in the same agitator and this water is not run to waste but contains appreciable quantities of acetone which the light oil fractions with low boiling point hold in solution.

Also the water condensed with the tar in the gas cooling plant contains recoverable amounts of acetone while its contents of ammonia amounting to 0.241 per cent and all fixed to acids at that, would not pay to bother with its recovery. The water which has been used for washing the light oil as well as the water driven off by the tar dehydrator are collected and distilled at a temperature of about 70 deg. C. (158 deg. F.) in an ordinary column still with indirect steam. The vapors driven off are condensed and the liquid consists mainly of water containing about 50 per cent

*This common expression is wrong and should be called "dust" since the solids in tar contain besides free carbon appreciable amounts of ash.

TABLE III
Tests of low temperature tar.*

	Tar collected from		Tar from collecting tank		Soft Pitch
	Air Condenser	Centrifugal Washer	Raw	Dehydrated	
Specific gravity	1.030	1.028	1.027	1.100	.....
Water, %.....	31.0	38.8	64.80	0.45	1.00
Light oil up to 130 deg. C. (266 deg. F.).....	12.9	9.0	8.50	.....	.....
Free carbon† (dust) %.....	.....	.....	.....	3.502	12.380
Hydrogen %.....	.....	.....	.....	7.45	5.20
Calorific value gross Cal.....	.....	.....	.....	9116	8200
Btu.....	.....	.....	.....	16,409	14,760
Calorific value net Cal.....	.....	.....	.....	8714	7889
Btu.....	.....	.....	.....	15,685	14,200
Sulphur .....	.....	.....	.....	0.64	0.84
Boiling point deg. C.....	156	158	154	162	150
(deg. F.).....	345	348	341	356	302
Distilling over in % up to, in deg. C.....					
160 (320 deg. F.)	2.0	2.0	1.0	.....	.....
170 (338 deg. F.)	4.0	3.0	2.0	5.5	.....
180 (356 deg. F.)	5.0	5.0	4.0	6.5	.....
190 (374 deg. F.)	7.0	6.0	6.0	7.1	.....
200 (392 deg. F.)	14.0	13.0	12.0	11.6	.....
210 (410 deg. F.)	18.0	16.0	14.0	18.3	.....
220 (428 deg. F.)	33.0	29.0	22.0	25.4	.....
230 (446 deg. F.)	41.0	32.0	27.0	31.1	1.0
240 (464 deg. F.)	46.0	37.0	31.0	36.1	1.5
250 (482 deg. F.)	48.0	41.0	35.0	38.5	2.0
260 (500 deg. F.)	51.0	43.0	37.0	40.3	2.5
270 (518 deg. F.)	54.0	49.0	39.0	42.0	3.0
280 (536 deg. F.)	57.0	51.0	41.0	45.0	3.0
290 (554 deg. F.)	59.0	53.0	45.0	47.8	3.5
300 (572 deg. F.)	61.0	56.0	46.0	48.9	3.5
310 (590 deg. F.)	63.0	57.0	50.0	51.4	6.5
320 (608 deg. F.)	68.0	59.0	52.0	54.0	8.0
324 (647 deg. F.)	70.0	.....	.....	.....	.....
330 (626 deg. F.)	.....	61.0	53.0	.....	9.0
340 (644 deg. F.)	.....	.....	57.0	.....	.....
345 (685 deg. F.)	.....	.....	64.0	.....	13.5
Residue (pitch) %.....	30.0	38.0	35.0	44.1	85.5
Loss in distilling %.....	0.0	1.0	1.0	1.9	1.0

*Distilled over open burner; results refer to tar without water.
†Free carbon in this case stands for solids which are insoluble in benzol-hydrocarbons.

acetone. This enriched product is again distilled carefully, the vapors passing through a finely adjusted dephlegmator when a very pure commercial acetone with a boiling point of 56 deg. C. (133 deg. F.) is yielded.

The chemical composition of the gas yielded in the revolving low temperature retort is shown in the table V where the averages from six tests are given. This is responsible for the sum of the columns being not exactly equal to 100 though the nitrogen is in each case determined by difference.

Interesting is the high calorific value of the gas as well as the complete absence of hydrogen which was determined over a heated capillary tube containing palladium asbestos. The absence of hydrogen is also apparent by the high specific gravity of the gas which closely approaches that of air. It should here be mentioned that the usually applied gas analysis methods where part of the non-absorbable rest is mixed with air and exploded in a pipette are in the case of low temperature gas very misleading and not applicable quite apart from the fact that some higher hydrocarbon like for instance buthane, completely escape the combustion by explosion and are thus determined as nitrogen. In exploding and calculating the results, appreciable quantities of hydrogen appear to be present, though, as already mentioned the specific gravity of the gas does exclude such a possibility from the start.

The heat balance of the plant, details of which would take up too much space here, is very satisfactory, the total losses being equal to 6.85 per cent so that 93.15 per cent of the heat introduced are recovered.

TABLE IV				Mixture of both from collecting tank 0.880
	Light oil from gas 0.935	Light oil from tar 0.820		
Specific gravity.....	0.935	0.820		
Distillation tests of crude light oils.				
Boiling point deg. C..	32	50		64
deg. F..	89.6	122.0		147.2
Distilling over in per cent, Deg. C. Deg. F.				
40 104	2	..		..
50 122	4	..		..
60 140	7	..		..
70 158	9	..		3
80 176	12	3		6
90 194	15	7		9
100 212	18	13		12
110 230	21	23		16
120 248	24	30		22
130 266	28	45		27
140 284	31	54		33
150 302	34	69		39
160 320	41	78		44
170 338	50	85		62
180 356	65	91		75
190 374	82	94		80
200 392	87	..		86
Residue consisted of	naphthalene*	tar	naphthalene*	
*Carried into the plant by the washing oil made from coke oven tar.				

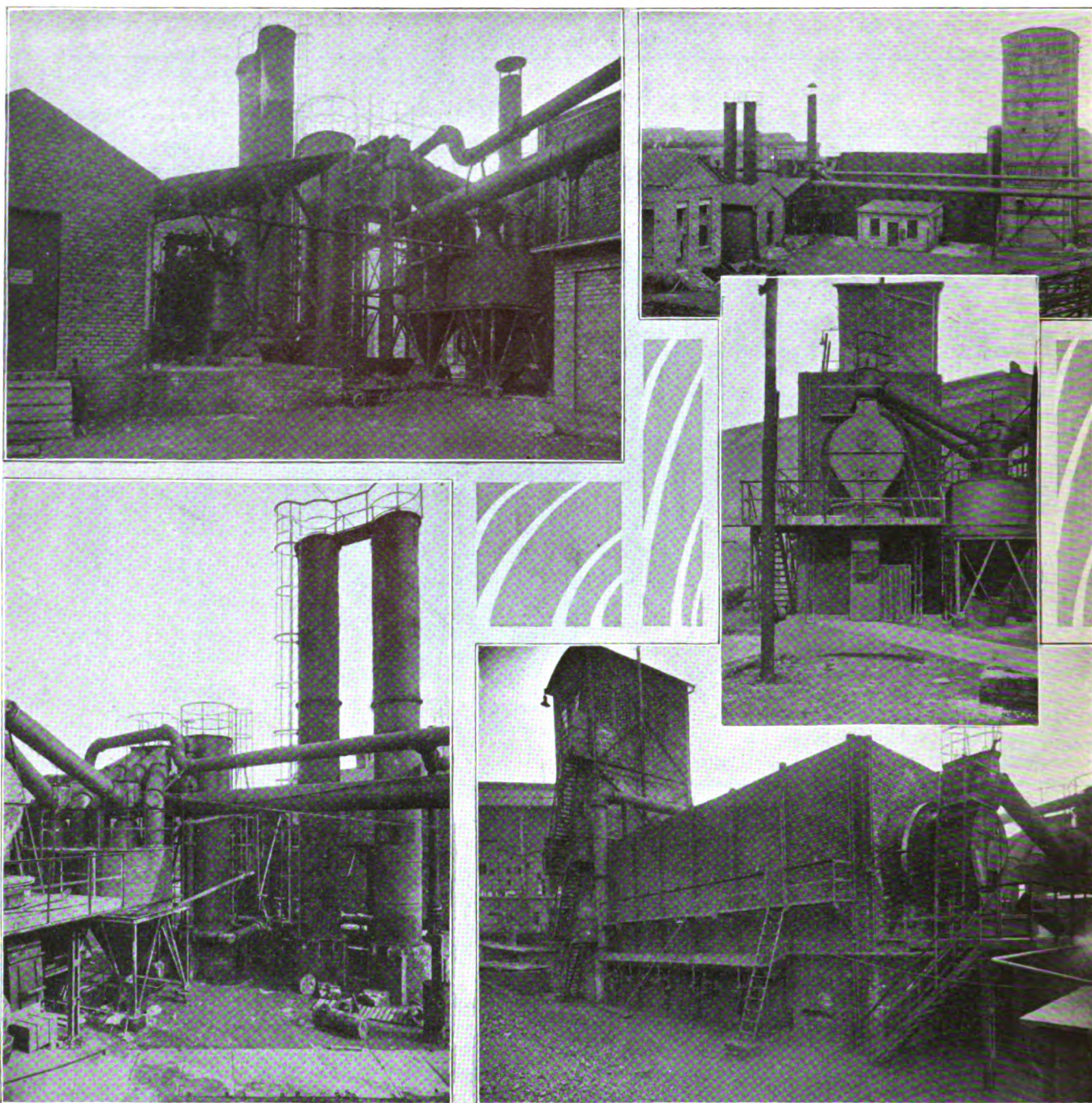


FIG. 4—Upper right shows a general view of the whole plant. FIG. 5—Lower right shows the retort furnace from burner side. FIG. 6—Middle right shows a view of the retort from the front. FIG. 7—Lower left shows pipes connecting headers and dust catchers. FIG. 8—Upper left shows gas collecting box.

The consumption of electric power amounts for the whole plant, as described above, to 30,22 kw. per hr., or 725.28 per day or 13.42 per ton of coal carbonized. Not included in this calculation is the current required for lighting purposes.

A balance sheet has been prepared after the first year of operation closed, showing a profit which would pay for the whole plant practically within two years of full work.

The plant at Gelsenkirchen has been at work over a year now and is being enlarged by the addition of a second retort for which purpose the two heating furnaces of the retorts will be placed side by side with a common partition wall in centre to reduce losses of heat by radiation to a minimum. The semi-coke pro-

duced is all taken up as powdered fuel for a large adjacent plant making cement from blast furnace slag. The gas produced by the retorts is conducted to an iron mixer in a foundry close by.

Fig. 4 shows a general view of the whole plant with the coal bunker building to the right, retort oven, dust catchers, chimney and light oil scrubbers.

Fig. 5 shows the retort furnace from the burner side. Above the blast furnace gas main a small gangway is fixed to reach the inspection holes above. Side by side with the blast furnace gas main a 2 in. pipe is seen being connected by a cock to each gas burner. The pipe leads to a small fan which blows air into the burners to obtain a good combustion, though as a rule it is not required. On the top of the retort header the

TABLE V
ANALYSIS OF LOW TEMPERATURE GAS
Average figures of six tests.

	Before light oil per cent	After scrubbers per cent
Carbon dioxide and sulphuretted hydrogen..	9.55	7.30
Heavy hydrocarbons.....	2.00	0.91
Ethylene	6.80	7.10
Oxygen	0.30	0.25
Carbon monoxide.....	4.32	4.50
Hydrogen	0.00	0.00
Methane and homologues.....	60.51	60.80
Nitrogen (by difference).....	17.01	19.25
	100.49	100.11
Specific gravity (air = 1).....	0.9414	
Calorific value gross, Cal.....	7853	7732
Btu.	883	869
Calorific value net, Cal.....	6735	6617
Btu.	757	644

two mushroom valves can be recognized of which one is open at the time and one closed. They connect the retort with the dust catchers by means of pipes.

Fig. 6 is a view of the retort from the front. The two connecting pipes between retort header and dust catchers can here be seen. To the right are the dust catchers with water seal underneath. Under the retort header the coke discharging arrangement is also visible.

Fig. 7 shows the connecting pipes between retort header and the two dust catchers, there being one inlet and two outlet pipes to each dust catcher respectively. To the right from the dust catchers is seen the air condenser and to the extreme right the two light oil scrubbers.

Fig. 8 is a view from the opposite direction of Fig. 5 showing the gas collecting box between dust catchers and air condenser. To the gas collector are connected the four outlet pipes of the dust catchers. To the extreme left is seen the exhaustor and pump house, next to it the centrifugal tar washer, the air condenser, gas collector, dust catchers and to the extreme right the retort furnace.

New Type of Cast-Iron House in Britain

By A. C. Blackall*

The British Ministry of Health has recently given its approval to houses the outer walls of which are constructed of standard cast iron plated, erected on a system devised by a Sheffield concern. These Thorncliffe type cast iron houses are eligible for the state subsidy provided under the Housing Acts of 1923 and 1924.

The outer walls are rough cast with a heavy layer of concrete. A patented method of jointing is employed between the flanges. The division walls and chimney breasts are built of brick work bonded into the cast iron shell. The internal walls to the ground floor rooms and bedrooms are formed of wood stoothing covered with asbestos and cement sheets. The roof is covered with tiles. The windows are wood case-ments securely bolted to the cast iron plates, while with the exception of the scullery and larder the floors are made of wood.

Unlike some of the new systems, it is possible with this system to quote definite prices for erection

*London, Eng.

within a 50-mile radius of the Thorncliffe Iron Works, near Sheffield, but are exclusive of the cost of founda-tions, drains, fencing, and footpaths, which obviously depend on the nature of the site. For a house con-taining on the ground floor a living room, measuring approximately 18 feet by 14 feet 3 inches, a kitchen, pantry, coal place and porch, and, on the first floor, three bedrooms, a bathroom, and a landing, contain-ing in all 875 superficial feet floor space, the price is £435 (\$2,175) each, delivered and erected in quanti-ties of not less than six.

A leading feature of the system is the extreme rapidity of erection. A specimen pair have been erected in 30 working hours in Sheffield, and have been made available for inspection. Cast iron shells of houses, complete with windows and outside doors, are also quoted on similar conditions at £150 (ap-proximately \$750) per house for a parlor house with three bedrooms.

Changes Announced in G. E. Personnel

Gerard Swope, president of the General Electric Company, has announced the appointment of T. W. Frech of Cleveland, Ohio, and W. R. Burrows of Har-rison, N. J., as associate managers of the incandescent lamp business of the company, effective September 1. They will relieve Messrs. G. F. Morrison, F. S. Terry, and B. G. Tremaine from the burdensome part of the responsibilities which have devolved upon them as managers of the incandenscent lamp business of the company for many years. For some time Mr. Mor-rison has not been in good health, and recently his physicians have advised that he obtain relief from a part of his business responsibilities.

George F. Morrison is a vice-president and director of the company, F. S. Terry is a vice-president, and B. G. Tremaine is a director. They will continue to be connected with the company in these capacities.

G. C. Osborne has been appointed sales manager of the Edison Lamp Division, a position formerly held by A. D. Page. Mr. Page will continue as a member of the advisory lamp committee, which now consists of Gerard Swope, G. F. Morrison, F. S. Terry, B. G. Tremaine and A. D. Page.

Bonus Systems for Office Employees

How to stimulate better production and to compen-sate efficient workers in the office, are problems that have been solved by use of a well adapted bonus system, according to several nationally known com-panies whose experiences have been given to the Policyholder's Service Bureau of the Metropolitan Life Insurance Company. Outlines of these systems are recorded in the fourth leaflet of the series on Com-pensation Methods — "Methods of Compensating Office Employees."

Citing the experiences of numerous organizations, the leaflet describes bonus systems for work suscep-tible of exact measurement, and for work which is not. The job analysis is also discussed as a basis for a well adapted bonus system.

Any interested executive may obtain a copy of the leaflet, without obligation, by writing direct to the Metropolitan in New York.

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CURRENT REVIEW

Current Literature on Ferrous Metallurgy

By E. H. McCLELLAND*

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Common Mistakes in Operating Stokers

By J. F. Barkley*

Conservation of fuel in boiler plant practice is one of the major projects of the Bureau of Mines. The large central stations, with their corps of trained operators and with refined equipment, obtain relatively good efficiency. It is in the many smaller isolated plants that the large fuel wastes are apt to occur. Some operators seem to feel that their responsibility is largely expressed in the phrase "carry the load," rather than "carry the load and carry it efficiently." Often equipment is not provided to give sufficiently accurate guidance to the operator.

In visiting many such plants, it is interesting to note how frequently the same mistakes occur. The following quite typical example illustrates some of these mistakes and their effect on operation. The boiler plant consisted of two 1,000-hp. boilers equipped with multiple-retort, under-feed stokers. These were horizontal water-tube boilers with horizontal baffling, having a high bridge wall at the back of the stoker. One boiler was used to carry a summer load of about 400 hp., and both were used to carry a winter load of about 1,250 hp. The operators felt that one boiler was not sufficient to carry the winter load. No instruments were available for the operator's use, excepting the steam pressure gauge.

A test under regular operating conditions was run on one of the boilers at the summer load. When the boiler was taken off the line and examined, holes in the baffles were found at the joints of the baffles and water legs. Some one-half tile had been omitted, which permitted short-circuiting of the gases. The necessity for a tight baffle is not always appreciated. The proportion of the gases that will pass through a hole in the baffle is much greater than the relative size of the hole to the proper passageway. It is similar to the case of a small hole through the fuel bed, or a small area of bare grate. A relatively small hole has little resistance to air passage, and can rob the fuel bed of much of its air.

The boiler setting appeared to be in excellent condition, to ordinary observation. There were no noticeable racks in the brick work. However, the common mistake of a leaky setting was there. Leaks were at the doors and at the joints of boiler and setting. Soot-blower nozzles placed at the ends of the boiler had backed out from the holes through the water legs, leaving holes for air leakage.

The main source of excess air, however, was through the stoker itself. It is very common practice to let too much air through the lower parts of the stoker. Where the air cannot be controlled by auxiliary dampers, especial care must be taken in keeping the parts properly covered with fuel. Where dampers are provided, they are often opened too widely. It is usually felt that the larger quantity of air burns out the carbon better from the ash, or keeps the ash cooler. Bringing the air needed for the top of the fire through the hot ash is an excellent plan, provided mixing occurs in the furnace. Since some of the air needed above the bed often gets in toward the front of the fire, the amount of air that may be brought in through the lower part of the stoker is limited even when mixing is effected. Frequently a

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number of long breaks parallel to the sides of the boiler develop in the fuel bed toward the back. Much flame occurs at these places and much air gets through. In general, the excess air should be cut down until losses from the formation of CO become too great. The proper adjustments can be made quite closely from the appearance of the fuel bed and flame. Experience can be gained best, perhaps, by taking flue gas analyses for various adjustments until the eye is trained to judge from the appearance of the fire. The knowledge of the CO₂ being produced is an excellent guide in operation. Quite frequently dampers are set and the load varied by varying the air pressure under the stoker and the coal feed. This will give efficient operation for a certain range of loads, but will not always handle extreme conditions, especially when not set correctly. As an example, on one occasion the steam pressure at a plant was dropping, due to an abnormal peak load. About twice as much air pressure was being used under the stokers as necessary in the vain attempt to carry the load. The air pressure was cut in half, the back dampers were shut to a narrow crack, and within half an hour the steam pressure was up, although the load increased during the time. Quite often dampers do not shut tight enough to keep down the air, even when the handles indicate the closed positions.

Another mistake, particularly in the older furnace settings, is not exposing enough water heating surface to the fire. The high bridge wall in the boiler being used as an illustration, permitted only a small part of the lower tubes to "see" the fire. The original idea was probably to obtain good mixing of the air coming up from the back of the stoker with the gases from the parts farther forward. A slanting cut was made across the bridge wall, lowering it somewhat and exposing the entire length of the tubes to most of the fire. It was found that the mixing action was practically the same. Making use of radiant heat direct to water heating surfaces keeps fire temperatures down, giving less trouble from clinkering. This can usually be secured by rearrangement of baffles or change in design of furnace. The baffles should be arranged, if possible, to guide the gases so as to leave no dead tube area.

In addition to these few simple changes on the boiler, an ordinary U-tube water manometer was placed to show the pressure of air under the stoker. One was also placed to show the pressure in the furnace. The firemen were trained in the use of manometers and in the proper appearances of the fire. Another test was then run under regular operating conditions at the summer load. The air pressure carried under the stoker was only about one-seventh as much as on the first test.

The high efficiency on this test is interesting in that curves of boiler performance usually are shown as dropping considerably at the very low ratings, the general idea prevailing that the losses will bring down the efficiency at these points.

It was found possible to carry the winter load at this plant with one boiler. Several tests were made at a winter load of about 110 per cent rating. None of these tests went below 80 per cent efficiency, this being without superheater or economizer. These changes raised the efficiency of boiler about 10 per cent, reducing the consumption of fuel about 13 per cent.—Steam Power.

Abstracts from Stahl und Eisen, August, 1925

Translation by J. Hahn, Pittsburgh, Pa.

Roasting of Ore. Dr. Hans Fleissner, Leoben. Conditions of equilibrium (balance) at the roasting of limestone. Effect of lowering (decreasing) carbonic acid pressure on decomposition. Thermic decomposition of siderite (spathic iron) in a current of carbonic acid, nitrogen, air and steam. Connection between temperature, time and size of pieces at calcination. Suggestions for reforming calcination.

Oxygen in the Steel. P. Oberhoffer, Aachen. The role of the oxygen at steel production. Research work of the writer in the determination of oxygen and its results.

The Application of the Shock (Impact) Bending Test on a Notched Bar. (Dr. Ing. Franz Laslo, Mülheim, Ruhr. Critical discussion of new research work which considers or applies the results on hand of tests made inland or abroad. Ideas on further development.

The Question of Plastic Deformation. Dr. Ing. H. Preussler, Gerlafingen. Pure deformation energy and ideal law of deformation. Influence of friction on the pressure surfaces. Law of the least resistance. "flow sheds" (Fließ scheiden). Law of compression with friction. Intermediate shapes. Plasticity and forming. Rearrangements. Increase and decrease of cohesion. Power (energy) required. Application to forging, pressing and rolling. Spreading, acceleration, deceleration, drawing.

Influence of Temperature on the Formation of Graphite in Pig Iron and Cast Iron. E. Pinomarsky, Aachen. The influence of temperature of the melting and the annealing time on the formation of graphite at the solidification of cast iron. Possibility of simultaneous existence of two kinds of molecules in melting (bath). Explanation of examples from literature and practice based on results of tests.

The Structure of High Grade Gray Iron in Its Relation to Chemical Composition and Mechanical Characteristics. Dr. Ing. R. Kuehnelt, Berlin. Relations between structure and chemical composition. Connections between tensile strength and hardness. Influence of cooling speed on hardness and tensile strength. Relation of hardness to structure and resistance against wear. Bending strength.

Low Carbon Cast Iron as Cupola Product. Karl Emmel, Mülheim, Ruhr. Advantages of low carbon cast iron. The Thyssen-Emmel process. Results of operation, scope of application. Malleable iron and cementation.

Modern Foundry for Heavy Iron and Chilled Iron Castings. Dip. Ing. Fr. Meisner, Duisberg, Manheim. General arrangement. Conveying system. Cupola furnaces. Dressing of sand. Molding and cleaning. Instruction of apprentices.

A New Furnace, "Wuest's Design," for Refining Quality Castings. Dr. Ing. Th. Klingenstein. The different ways of refining cast iron. The Wuest air cupola. Its design and operation. Results and advantages.

Foundry for Malleable Iron of Latest Arrangement. Conveying system. Moulding and core making. Core drying, melting and annealing furnaces with oil burners. Cleaning room.

Preparation of Samples for Chemical Analysis

Users of steel castings occasionally wish to determine the chemical composition of the metal, because of difficulty in machining, failure in service, or other reasons. Sometimes a consumer reports a determination made by or for him, which varies considerably from that reported by the foundry. When a complete investigation of all the factors involved in chemical analysis is made, it is frequently found that divergences in results are due to the slighting of certain procedures, appreciated fully by the analyst daily making many steel analyses, but not always by those who seldom do such work. We learned recently that a well known commercial laboratory frequently receives steel samples in such condition as to prevent accurate analysis. This prompts an explanation regarding unsuitable samples, from which chemists make determinations that occasionally form the basis of important controversy.

Care should be taken to remove all oil or grease from the surface to be drilled for preparing samples. Similarly, the tools used in making the drillings should be free from lubrication and otherwise perfectly clean. Oils contain considerable carbon; therefore, a very small amount of grease mixed with the sample will cause a considerable error in the results obtained on a carbon determination.

Should there be doubt as to oil contaminating the drillings, and should there be no possibility of securing other drillings known to be free from oil, the chips should be washed in ether two or three times. If ether is not available, the drillings may be cleaned in a fairly concentrated solution of caustic potash or soda, and then dried immediately after immersion in an alcohol solution.

In addition to being free from oil, the surface to be drilled should be uncontaminated by scale, dirt, adhering sand, or other foreign matter. Removal of these materials can be effected by the shallow grinding of a small area surrounding the location to be drilled. Scale, sand, or dirt affects the determination of any element because of false weight obtained on the sample used, and precipitates weighed in gravimetric determinations. If, despite all care that can be taken, the sample is suspected to contain any of these foreign materials, they can be removed by the careful use of a magnet.

In drilling the specimen, it is important to discard all chips formed by the drill within $\frac{1}{4}$ inch of the surface. The surface metal may not represent the body of the casting because the "skin" can be affected by heat treatment operations and by exposure to atmospheric conditions while at high temperature. It may be oxidized, carbonized, or have its sulphur content raised by the products of combustion during heat treatment.

The drill used should be of the flat type, as it produces finer chips of a more uniform size than does a twist drill. The latter is apt to penetrate too rapidly, causing an overheating of the drills. These should show no color resulting from heat. The chips should be neither too fine nor too coarse. Those that pass through a 20-mesh, but remain on a 60-mesh sieve give concordant results. Large drillings do not yield their carbon readily in the combustion furnace be-

cause of the difficulty of fusing the heavy sections of the chips.

To prevent variable results, due to any segregation of the elements, it is important to make a very thorough mechanical mixture of the chips prior to starting any determination. This is one of the reasons for the use of small drillings. Segregation in steel is a phenomenon that is principally caused by slow cooling. Only by the thorough mixing of small chips can the analyst be sure of getting determinations representing average conditions.

Summarizing, incorrect determinations may result from the following causes:

Carbon

High

- (a) Oil in sample.
- (b) Sand or dirt in sample.
- (c) Splinters from wood drilling block, in sample.
- (d) Poor mixing of sample from casting affected by segregation.

Low

- (a) Drillings too large in section.
- (b) Drillings too small in section.
- (c) Scale in sample.
- (d) Burnt chips in sample.
- (e) Poor mixing of sample from casting affected by segregation.

Manganese

Low

- (a) Sand or dirt in sample.
- (b) Scale in sample.
- (c) Poor mixing of sample from casting affected by segregation.

Silicon

High

- (a) Sand or dirt in sample.
- (b) Poor mixing of sample from casting affected by segregation.

Low

- (a) Scale in sample (if volatilized).
- (b) Poor mixing of sample from casting affected by segregation.

The determinations for phosphorus and sulphur are not so readily influenced by the above causes except segregation, and except as foreign matter will affect weighing of the chips. Samples taken for these two elements are larger than for the three mentioned previously, so that the relative influence of weight of foreign material is reduced, in determining phosphorus and sulphur.

Extended experience acquired in chemical laboratories connected with steel foundries emphasizes the importance of precautions such as have been outlined, the substance of which is given in numerous textbooks describing analytical methods. Chemists who only periodically have occasion to make steel analyses are sometimes inclined to minimize the effect of some specific instructions, necessary to follow in making accurate determinations, either as the basis for regulating foundry practice, for confirmation of plant analyses, or for use in the comprehensive study of difficulties experienced with the parts analyzed.

—Research Group News.

THE SAFETY CRUSADE

Putting Over A Safety Drive

Organization and Attention to Every Detail Insures Success—
Report on No-Accident Drive

EARLY in the year the idea of a no-accident month was suggested to General Superintendent S. G. Worton of the Duquesne Works, Carnegie Steel Company, Duquesne, Pa., and his approval and promise of personal participation obtained. The various department superintendents were next consulted and promises of co-operation gotten. The subject was then taken up with the departmental safety committees throughout the plant and the idea received their endorsement.

During the month of April at the regular safety meetings and special meetings of groups in the various departments, talks were made by Mr. John A. Oartel, Chief of Bureau of Safety, Carnegie Steel Company, and D. C. Burroughs, Assistant General Superintendent. P. G. Fenlon, Superintendent of Safety and Welfare, outlined the program and proposed activities, asking support of the drive from every employe.

On the last pay day in April each employe received in his pay envelope a card notice of the drive and was asked for his personal interest and co-operation. The message and request was sent out by General Superintendent Worton, worded as follows:

TO ALL EMPLOYEES OF THE DUQUESNE WORKS, CARNEGIE STEEL COMPANY

A special drive will be made during May to prevent accidents in this plant. With your help we can go through the month without a lost time accident, and we ask you to do your part by being careful of yourself and your fellow workmen.

Injuries result in loss of time and suffering to those who are injured and cause suffering and sadness in the homes.

We want to stop accidents. We ask and expect your help in this drive.

S. G. WORTON,
General Superintendent.

On the evening of April 30th, a mass meeting for superintendents, assistant superintendents, foremen, and men directing work in the plant was held in the Duquesne Carnegie Library. This meeting was conducted by P. G. Fenlon. An orchestra furnished music and safety addresses were made by John A. Oartel, Dr. C. H. Rust and General Superintendent Worton.

The publicity features were ready for the drive start-off. Large streamers had been erected at all entrances to Upper and Lower Works. These streamers bore the following notice and appeal:

MONTH OF MAY—NO ACCIDENTS

We are asking every employe of the Duquesne Plant to work for the prevention of accidents dur-

ing the month of May. Your part is to think safety and act safely. Every employe must help in order to make a clean record. Do not have it said that you failed to do your duty to yourself or a fellow workman. We ask and will appreciate your earnest efforts for safety.

S. G. WORTON,
General Superintendent.

Publicity matters such as posters, slogans, photos, etc., were displayed on all general bulletin boards.

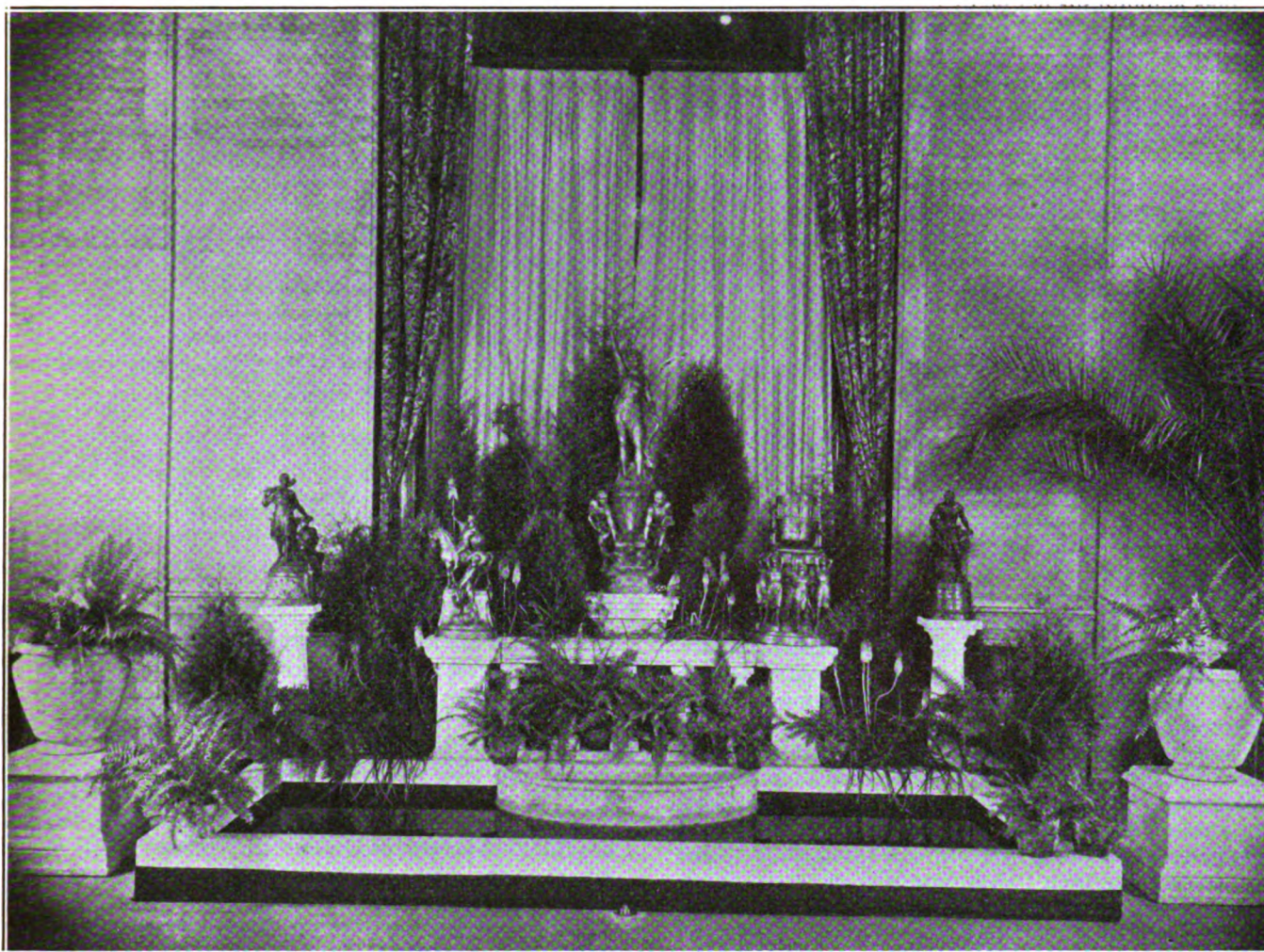
Departmental publicity was delegated to each department for its own ideas and promotion. It would take too much space and time to enumerate all methods and messages. They ranged from meetings at which impromptu orchestras participated in entertainment, displays of safety appliances, special posters and prints pertaining to particular department hazards, talks by superintendents, talks by foremen at beginning of each turn, stickers bearing messages pasted in conspicuous places, slogans worked out in white-washed stones placed on grass plots, etc., and one superintendent used cards similar to those of a political candidate. Front of card showed his photo and name, worded as follows:

"Not a candidate for any office—But your support for **Safety** is earnestly solicited."

Back of card worded as follows:

"I take the liberty of placing this card in your pay envelope. Even a slight injury to you may cause a shortage in your pay. Won't you help me, as Superintendent of Bar Mills 5-6-7, make this campaign for safety 100%—with no lost time caused by an accident?"

Also starting May 1st, plant mass meetings were held at three designated places. The first at 10 o'clock A.M. in building near Rolling Department. This meeting was attended by all employes from south section of Upper Steel Works. Attendance about 1,800. Second meeting at 11 o'clock A.M. in Main Machine Shop. Attended by all employes in north section of Upper Steel Works. Attendance about 1,200. Third meeting at 2:30 o'clock P.M. in No. 3 Merchant Mill, Lower Works. Attendance about 1,000. During the period of these meetings, which were of 30 minutes' duration (orchestra played while men assembled, special speaker talked 20 minutes and S. G. Worton, 10 minutes) work was suspended in all departments affected and mills stopped operating. Every employe in plant attended these meetings. Also all department superintendents and assistants attended all



Carnegie Steel displays in group at the National Safety Council in Cleveland the five symbolic bronzes which have formed the background of their Safety Campaigns.

mass meetings, thereby attesting their support throughout the plant.

These plant rallies were held on Thursday of each week and were addressed by the following speakers in turn: John A. Oartel, Chief of Bureau of Safety, Carnegie Steel Company; A. C. Cook, Superintendent of Safety and Welfare, Youngstown Works, Carnegie Steel Company; Francis Feehahn, Safety Inspector, U. S. Bureau of Mines, Pittsburgh; Harry Sparr, Fire Chief, Edgar Thomson Works, Carnegie Steel Company, and G. E. Clarkson, Secretary, Western Pennsylvania Division, National Safety Council, Pittsburgh. All plant rallies were attended and addressed by General Superintendent S. G. Worton. On May 7th, in addition to the special speaker and General Superintendent Worton, meetings were addressed by President Homer D. Williams of the Carnegie Steel Company.

These activities resulted in a period of 26 days without a lost time accident with a working force from 6,500 to 6,700 men. The first lost time accident occurred May 27th. On the twenty-ninth day another accident occurred, making a total of two for the period of the drive—showing a reduction of 76.35 per cent over month of April, 1925, and a reduction of 85.34 per cent over May, 1924. Of the two accidents occurring during this month one was unpreventable and not due to man failure. The second was caused by

a man dropping a billet on his toes, attributable to his own carelessness.

At the conclusion of the drive General Superintendent Worton sent out a card of thanks to each employe as follows:

TO ALL EMPLOYEES OF THE DUQUESNE WORKS, CARNEGIE STEEL COMPANY

Thank you for your assistance during the No-Accident Drive in May. Only two lost-time accidents occurred, and while I most sincerely regret that one man died as a result of his injury, I still want to commend you for the part you took in reducing accidents.

This drive was for the purpose of bringing home to each man the realization of the suffering and sadness that follows accidents; what it means to you as an individual; what it means to your family; your fellow workmen and his family. I consider it the most worthwhile thing we can do for one another, so I ask that you continue looking out for your safety, and the safety of the men with whom you work.

If you will continue to co-operate for safety, I am sure it will make you a better and safer man, make our mill a safer place in which to work, and our town a happier place in which to live.

S. G. WORTON,
General Superintendent.

Before concluding we want to record our indebtedness to the special speakers who so generously gave of their time and talents in the work of our drive and whose talks were received with profit alike to all. And to the men of our own organization in every department, superintendent, and including the entire department force, we want to express our gratitude for the support of this safety drive and the splendid spirit in which they participated. And while we did not wholly attain a goal of our objective—complete a month free of accidents—let us say in all sincerity and appreciation, as we know of no truly greater way to express our gratitude, that, were it possible to lose a record without resultant suffering on the part of an injured employe, we would gladly sacrifice that accomplishment for the splendid spirit of our organization.

The results obtained in this safety drive convinces us that 100 per cent perfection can be achieved in accident prevention, and this should be the aim of every employe and organization within a plant. That it is the business of the safety superintendent or director to promote and procure co-operation and then to rightfully give credit and commendation for the accomplishment of results. By co-operation we mean the inclusion of officials and workmen alike, for without the full support of official heads of organizations, complete results are not possible of attainment. And in summing up the most effective features of our drive, and not detracting one whit from the spirit and co-operation of department heads and their safety organizations, without which no drive could succeed, yet in our opinion the presence and participation of General Superintendent Worton, speaking at all plant rallies, asking the men to support this effort to eliminate accidents, pleading for the homes of those who would suffer most when accidents occur; and then the presence and talk of President Williams, who told the men of the great amount of safety work that has been done by the Carnegie Steel Company and the United States Steel Corporation in general, and promising his support to further accident prevention, were, without doubt, the most valuable contributions to the drive's success and will be productive of lasting results.

No Lost Time Accidents

The Mixer congratulates its men in the following words:

The attaining of this premier accident prevention record at Joliet Works is not only a wonderful and remarkable contribution to the cause of the conservation of human lives and resources, but is a most emphatic tribute to the loyal and untiring devotion to this cause exhibited by every foreman, every safety committeeman and every worker in the plant.

In view of the many fine reductions and other records which have been made at Joliet Works the full significance of this achievement may not at first be entirely realized.

Since the inauguration of the accident prevention campaign at Joliet Works many years ago the campaign has always been successful to the extent that we have been able to show a decrease in our percentage of accidents at the end of each year over the preceding year. This in itself is most emphatically a matter of the greatest pride on the part of every employe. When our remarkable achievements of the year 1924 were recorded, when there were but seven

cases where it was necessary for a man to be away from work more than seven days on account of an accident and none of these of a serious or permanent disabling nature, together with the three long no-lost-time periods of 95 days with an average of 3,891 men employed per day, 61 days with an average of 2,758 men employed per day, and 89 days with an average of 2,788 men employed per day, with such a wonderful year, we were inclined to feel that such a tremendous and gratifying contribution to the great humanitarian work of conserving human life and resources was about as large a contribution and as nearly perfect as we could hope to attain, considering the failures and frailty of human nature and especially that seemingly inherent trait in all us Americans and our love of "taking a chance."

However, the fact that we have been successful in adding several chapters to our plant accident prevention history thus far during the year 1925 greatly adds to the significance of the achievement.

The first long no-lost-time accident period for this year was from February 17th to April 4th, a total of 45 days with an average of 3,844 men employed per day without a lost time case.

During this period a total of 2,760,141 hours were worked. This huge total without a lost time accident denotes perfect efficiency in our accident prevention campaign and we feel that a record has been established for an industry where conditions are comparable to ours.

During this year we also have had four calendar months during which no lost time cases occurred. The first month being the month of March, the next notable achievements were the three other months which were also consecutive, being the months of May, June and July.

In attaining this premier record, a fact of outstanding importance and significance is that during this period most efficient operating conditions prevailed in all departments and in addition production records were broken as well, thus fully completing all essentials of an entirely efficient safety record.

In not only equaling but bettering our previous record we feel that the accomplishment is indicative of the entire worthwhileness of our effort and of the

American Welding Society

(Continued from page 429)

of the Grinnell Company. Evening: Special exhibition and demonstration of welding and cutting applications.

Thursday, October 22 — Morning: "Industrial Applications of Arc Welding and Economies Effectuated Through Its Use." Joint paper by H. M. Hobart, Chairman, Electric Arc Welding Committee, and W. Spraragen, Secretary. Afternoon: Meeting of American Bureau of Welding. (Research Department of Society.) Program will include review of present activities and outline of future investigations. Afternoon: Meeting of Board of Directors of the American Welding Society. Evening: Dinner party. Theater party.

Friday, October 23 — Morning: "Selection of Materials for Welding." A series of short addresses by several prominent experts on this subject. Afternoon: "Manufacture of All Steel Automobile Bodies" (illustrated by moving pictures). J. W. Meadowcroft, General Supervisor of Welding, E. G. Budd Manufacturing Company.

Power and Fuel Consumption of the Iron and Steel Industries of Pittsburgh

By SUMNER B. ELY* and W. F. RITTMAN*

THE Carnegie Institute of Technology through its Commercial Engineering Department is conducting a major investigation of present power requirements and potential future power possibilities in the Pittsburgh District (1) with relation to the community and its development as a whole, and (2) with relation to the various specific industries of the community.

The largest and most important industrial activity of the district is the production of iron and steel, and the first step has naturally been to make a detailed study of that industry with relation to its power requirements.

Some idea of the quantity of steam used by the steel industry within the 30-mile radius around Pittsburgh can be had from the following interesting comparison with the Superpower Survey for the region between Boston and Washington lately published by W. S. Murray and others. If the boiler horsepower-hours as shown in the Pittsburgh power-study curve for the year 1920 (see curve b, Fig. 2) are put into equivalent kwh., it will be found that this figure is about two-thirds of the total industrial kwh. for the same period as given in the Superpower Survey for the whole district covered by it.

The value of such a survey lies (1) in the importance of the Pittsburgh District as a factor in the nation's steel production, and (2) in the fact that the data will serve as a basis of comparison when corresponding data are collected for other steel centers. Furthermore, any development in the use of or in the creation of power for the steel industry is of vital concern to the other industries of the community, and, in fact, of interest even to concerns located within a radius of 100 miles or more from Pittsburgh. Finally, it was felt that a detailed study of power and fuel consumption in the steel industry in a district as important as that embraced by this investigation would give some indication as to the general trend of developments during the period covered, and there is

good reason to believe that this expectation has been justified.

Points Brought Out by the Survey.

The data presented show certain marked developments in the power phase of the steel industry. First, they reveal a greatly increased use of given equipment—expressed by the increased load carried by each unit of physical equipment; and secondly, a marked increase in cost of fuel use coinciding with the war years. The curves drawn from data obtained in this survey indicate the volume and importance of power as a factor in determining steel production costs. A continuation of such curves will register changes in efficiency, while the accurate cost data obtained will undoubtedly be useful for future planning.

The Pittsburgh undertaking has taught a valuable lesson in regard to what might be called the art of making industrial surveys. It is obvious that the value of such a survey is primarily dependent on the ability of those making it to ascertain the facts which shall form the foundation of the deductions later made, and what is perhaps even more important, the ability to ascertain all the facts and not merely those easily accessible, and to express them in a comparable manner and in sufficient detail to enable one to obtain a clear insight into their significance.

In this connection it appeared early in the study that some of the institutions investigated either did not have the necessary facts properly collected or were reluctant to give detailed data as to their costs, fuel and power consumption, efficiency and so on, on the ground that their organizations might show up unfavorable in comparison with others, or that because of their size they would be accused of monopoly in their particular branch of the industry.

There was no way of compelling compliance with the request for facts, and even if there had been it would have been probably extremely unwise to have employed it. It was decided that the only way to collect data was to obtain it from the individual companies, which meant that, speaking colloquially, the idea of the survey had to be "sold" to these com-

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panies, and that the various institutions involved had to be instilled with sufficient faith in the Carnegie Institute of Technology to entrust it with this confidential detailed information. This situation was met by a general agreement that no specific data referring to individual companies would be published and that all the data would be used only in combination so that only summation or overall figures would be shown.

In the spirit of confidence and mutual goodwill thus created it became comparatively easy to meet the next obstacle, namely, that different institutions used different units of measure and different ways of keeping records, which made interpretation difficult. This was done by the various parties involved joining about a common table and placing their respective engineers in conference for the common end. For instance, in the case of the public utilities, the data and trends were developed by engineers from the various utilities in counsel with the Carnegie Institute of Technology. There are indications that these conferences and the work done on the survey may lead to a greater completeness and uniformity of power and fuel consumption records in the steel industry of the Pittsburgh District. Further, the work has effectually shown that the community or industrial inventory can be made only with the complete co-operation of the community and industry.

In general, it will be noted that the period covered by the curves presented is one of the most interesting in the history of our country, namely, that of the world war, but with a few overlapping years so that an idea of the trend is given and the distortion produced by the war indicated. Take for example the efficiency curve shown in Fig. 13 (a), which indicates how the efficiency of firing fuel varied during the war years and as what occurred in the Pittsburgh District is typical of what took place in most of the manufacturing

districts of the United States it is not unreasonable to say that these curves in great measure reflect other manufacturing industries; so that by the study of these curves we can learn something, broadly speaking, of the condition of the whole country.

Again, a tendency to work equipment beyond its capacity is distinctly shown at the beginning of the war—possibly because additional equipment could not be obtained promptly—and later on an increase in equipment is evident. This undoubtedly reflects the general conditions then prevailing in most manufacturing industries, and while this agrees with general opinion, the curves provide a definite, concrete verification.

Furthermore, it must not be forgotten that power is approximately proportional to production, and that the curves indicate in general the demand for steel and iron. The general rise in the price of fuel has not been confined to the Pittsburgh District, so that the percentage increase in the cost or price of fuel gives a fairly good idea of what happened throughout the United States, or the eastern half of it at least.

Defining the Pittsburgh District.

The corporate limits of the City of Pittsburgh long ago proved inadequate to hold the manufacturing establishments and plants which now spread up and down its rivers and arteries of transportation. They

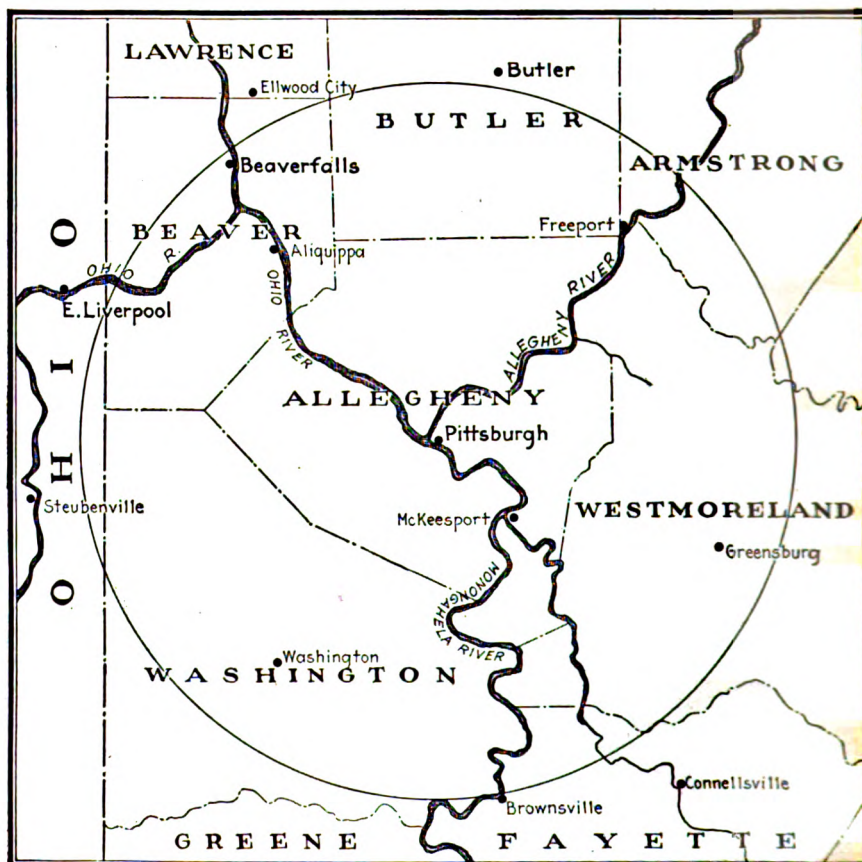


FIG. 1—The Pittsburgh District studied, which embraces the area within a radius of thirty miles from the city's center.

are much more restricted than those of most metropolitan districts, but serve as the hub of the fifth major district of the country and embrace a population of over 1,200,000. The area selected for this study was that of the circle struck with a radius of 30 miles from the Pittsburgh City County Building as the center (see Fig. 1), because the people and the iron and steel plants comprised within it are intimately associated with and largely dependent upon the facilities of corporate Pittsburgh.

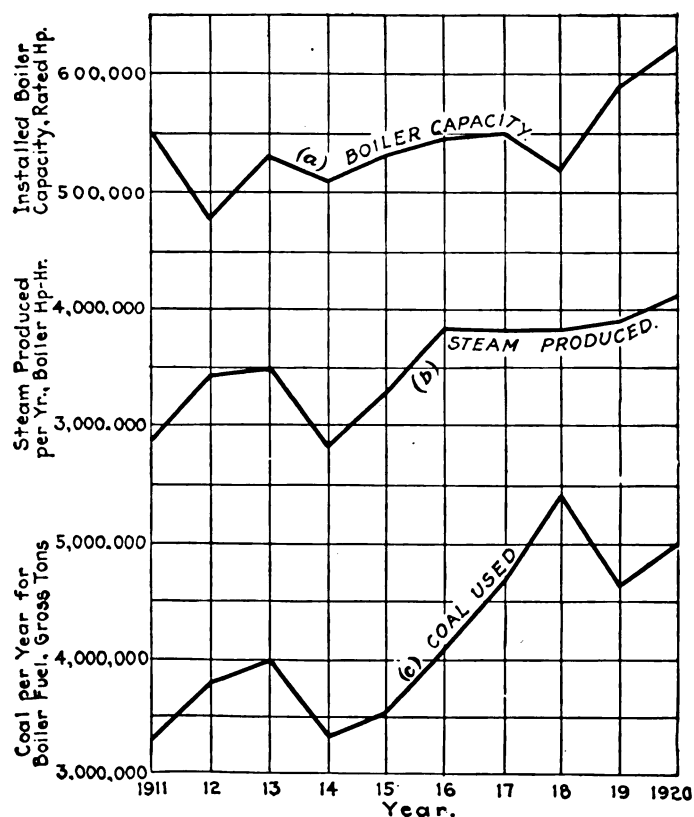


FIG. 2—Curves showing (a) total rated horsepower capacity, (b) total quantity of steam produced, and (c) coal used for boiler fuel in all steel works of the Pittsburgh District.

(Note: 1 hp. rated capacity = 10 sq. ft. of heating surface.)

Note.—“Steam Produced” should read in billions.

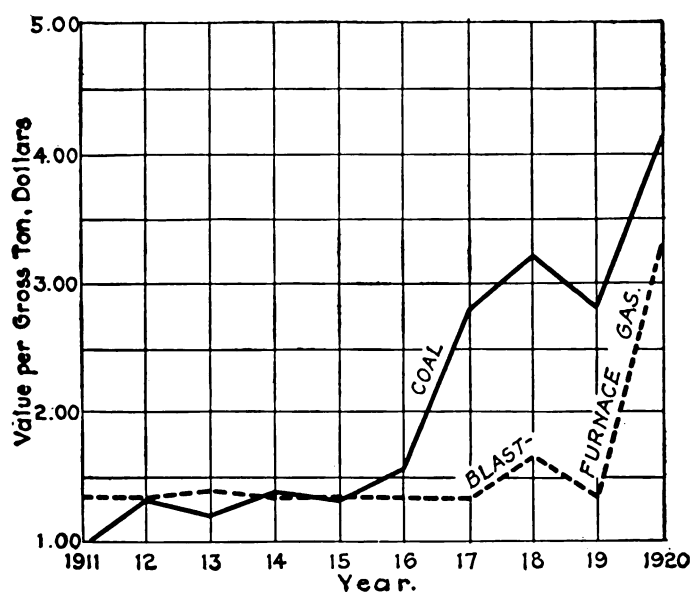


FIG. 3—Curves showing value of coal and blast-furnace gas used for boiler fuel in all steel works of the Pittsburgh District.

Summary of the Data Presented.

Naturally, a large number of sources of information are used in a study of this character. The various iron and steel interests of the community were most obliging in furnishing the data at their command. In addition, the authors were helped greatly by the Pennsylvania Department of Internal Affairs, by the Interior Department at Washington, by the officials of the American Iron and Steel Institute, and by the various technical journals and publications of the industry.

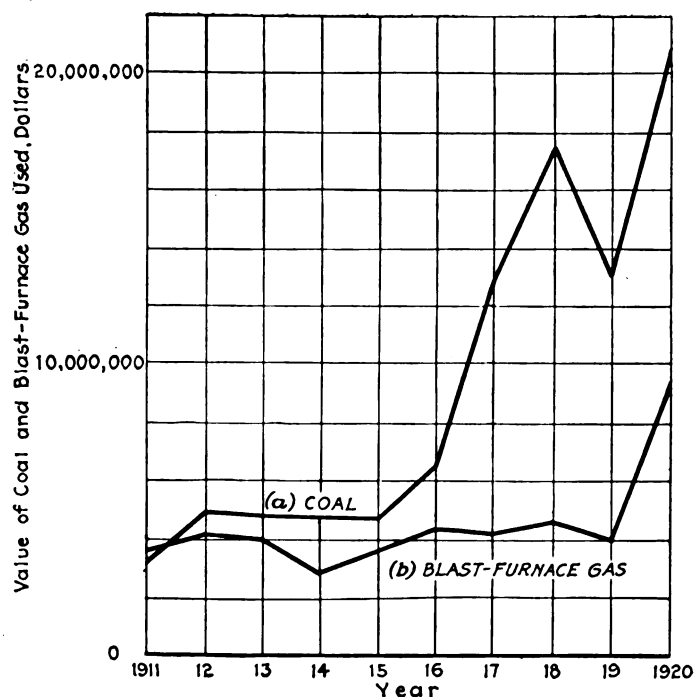


FIG. 4—Curves showing value per gross ton of coal and blast-furnace gas used as boiler fuel in all steel works of the Pittsburgh District.

(Note: Value given for a “gross ton” of blast furnace gas is for the quantity of gas that will develop the same amount of heat as one gross ton of coal.)

Table I presents the summation data covering the more important items entering into this study. To the business man the figures given in this table are valuable as covering the more important elements

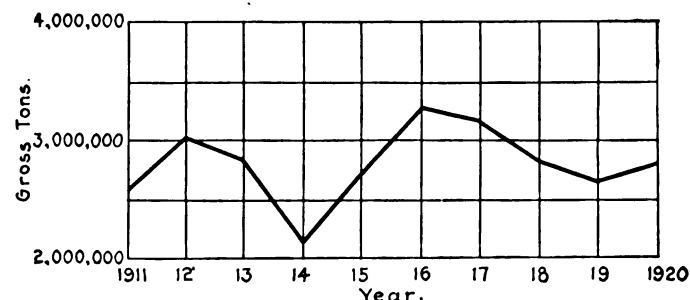


FIG. 5—Curve showing “gross tons” of blast-furnace gas used for boiler fuel in all steel works of the Pittsburgh District.

(See note under caption of Fig. 4.)

and relationships entering into the industry, but to the iron and steel engineer or the power engineer the detailed data and relationships are of equal if not greater interest. Column 1 shows the total gross tons of fuel, coal equivalent, used under boilers; column 2 the cost of this fuel, and column 3 the gross tons of ingots produced with this fuel. The three succeed-

ing columns cover data derived from the first three columns. These data show that as the number of gross tons of steel ingots rose from approximately 10,000,000 in 1911 to 13,000,000 in 1920, the value of the fuel used under boilers increased from less than \$7,000,000 to more than \$29,000,000. On the other hand, the fuel used per gross tons of ingots produced

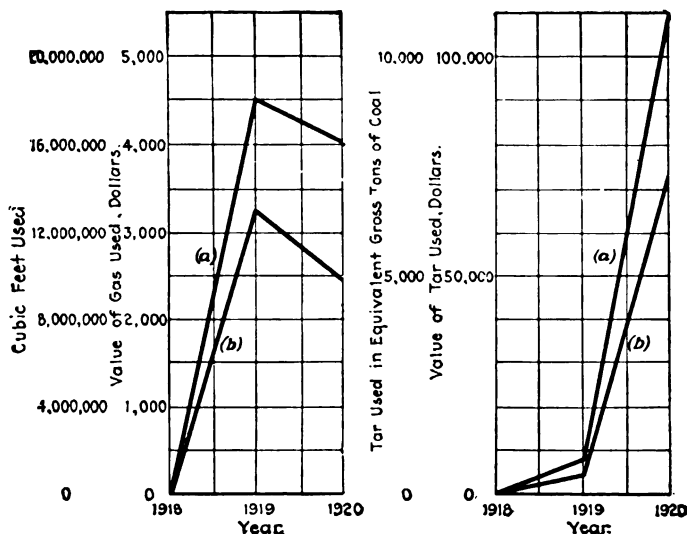


FIG. 6—Curves showing (a) quantity and (b) value of natural gas used for boiler fuel in all steel works of the Pittsburgh District.

FIG. 7—Curves showing (a) quantity and (b) value of tar used for boiler fuel in all steel works of the Pittsburgh District.

(Note: A "gross ton" of tar is the quantity of tar that will develop the same amount of heat as one gross ton of coal.)

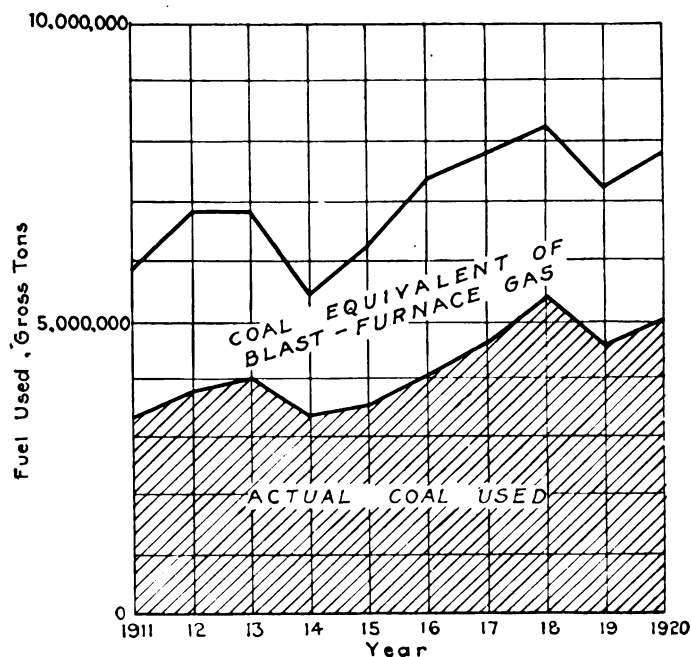


FIG. 8—Curve showing total quantity of fuel used under boilers in all steel works of the Pittsburgh District.

(Note: See note under caption of Fig. 4.)

increased only from 0.57 ton to 0.60 ton, and the value of fuel used per gross ton of steel ingots produced increased from \$0.65 in 1911 to \$2.27 in 1920.

The rated-capacity curve, Fig. 2 (a), represents the boiler capacity of all the iron and steel plants in the district. The curve shows practically no increase in the installed boiler capacity during the years 1914

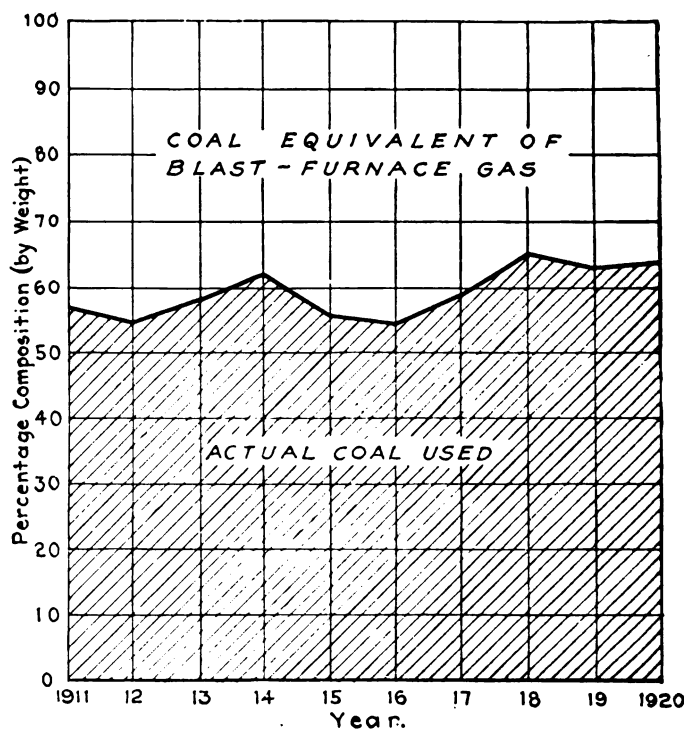


FIG. 9—Curve showing percentage composition (by weight) of the average gross ton of fuel used under boilers in all steel works of the Pittsburgh District.

(Explanation: In 1916, e.g., one gross ton of average boiler fuel consisted of 55 per cent coal and 45 per cent blast furnace gas. See note under caption of Fig. 4.)

to 1917, but a tendency in that direction since 1918. In no case has the increase in boiler capacity been in proportion to the increase in production; in other words, increased producing capacity was attained largely by the harder and more efficient use of the existing equipment.

The output curve, Fig. 2 (b), gives, in boiler horsepower-hours, the total quantity of steam produced per year by the installed rated capacity shown by curve (a). By superimposing curve (b), on curve

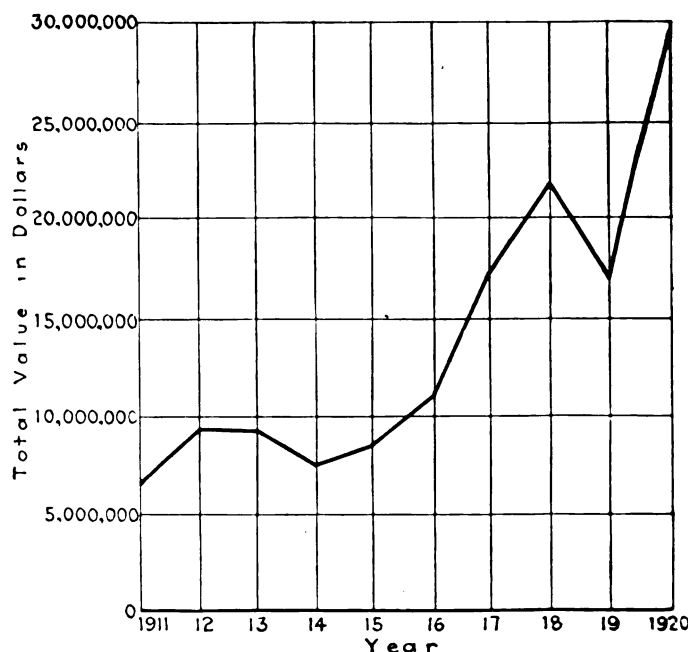


FIG. 10—Curve showing value of fuels of all kinds used under boilers in all steel works of the Pittsburgh District.

(a), the extent to which greater utilization was secured from existing equipment becomes evident.

The coal used is shown in Fig. 2 (c), and is the tonnage actually fired under the boilers to produce the steam shown by curve (b) of the same figure. This curve appears to correspond closely with curves (a) and (b) in showing a fall in 1914 and then a greatly increased activity through 1920. A pronounced peak is evident during 1918. Personal investigation has developed the fact that much of this increase was not the result of efficient expansion. During that period firemen as a group showed a considerable labor turnover with resultant inefficiency in the use of a given volume of fuel, and considerable coal of less de-

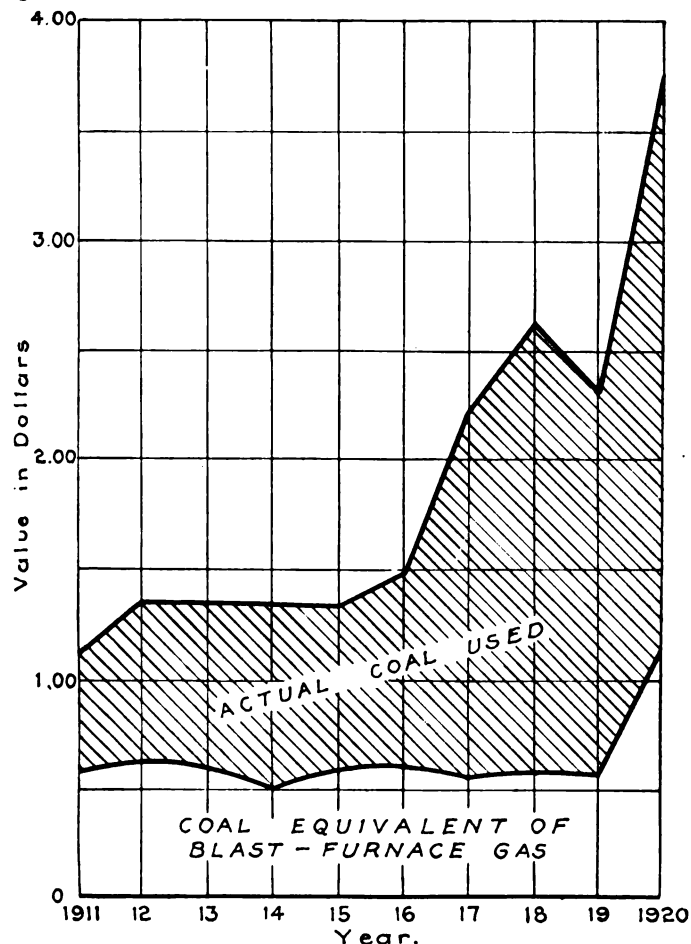


FIG. 11—Curve showing value of one gross ton of fuel used under boilers in all steel works of the Pittsburgh District.

(Explanation: In 1916, e.g., one gross ton of average steam fuel consisted of 61 cents' worth of blast furnace gas and 87 cents' worth of coal, making the fuel equivalent of one gross ton of coal cost \$1.48. See note under caption of Fig. 4.)

sirable character was used. Facts like these are not shown in the statistics but are of primary importance.

The total value of the coal used is shown in Fig. 3 (a). The rise in this curve from 1915 to 1918 is greater than the rise for the same period in the tonnage curve, Fig. 2 (c), reflecting that the price per ton was advancing during the period—as might well have been expected from the demand at that time. The total amount of money paid for boiler coal during the year 1920 was in excess of \$20,000,000.

The price of boiler coal per gross ton throughout the period is shown in Fig. 4, and was derived by dividing the values of curve (a), Fig. 3, by the tonnage volume of curve (c) Fig. 2. The price variation during the period is vividly portrayed. A persistent

upward tendency running from \$0.955 in 1911 to \$4.10 per gross ton in 1920 accords with the trend of all commodities during the period.

The total blast furnace gas used under boilers is shown in Fig. 5. In order to have a better basis of comparison, the cubic feet of a gas are expressed in terms of coal equivalent. The ratio used is 103 Btu. per cubic foot of gas to 13,500 Btu. per pound of coal.

The value of the blast furnace gas used, Fig. 3 (b), was estimated by valuing the quantities shown in Fig. 5. Considerable difference of opinion naturally existed as to what this value should be. A few years ago blast furnace gas, being a by-product, was considered as of small value. Today, however, iron and steel manufacturers distribute a book charge for this gas, generally against the power plant, which is right and proper. The generally agreed upon value of the coal equivalent is \$1.35 per ton, but in 1920 this figure was changed to \$3.27. The weakness of such empirical assumptions is recognized, but so long as the basis of calculation is understood, each reader can revise the conclusions as he may see fit.

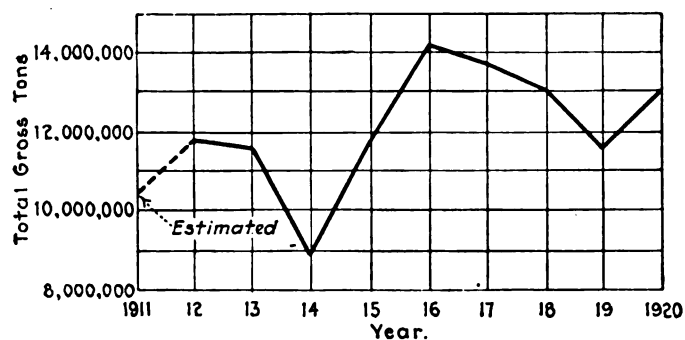


FIG. 12—Curve showing total quantity of steel ingots produced per year in all steel works of the Pittsburgh District.

The natural gas used under the boilers in the iron and steel industry is shown in Fig. 6 (a). The amount consumed was very small, and prior to 1918 was of such small volume as to be negligible.

The cost of natural gas used under boilers is shown in Fig. 6 (b), and during 1919 was only about \$3,000, an amount so small as to be of little importance in the total figures. The curves show that the average cost of the 18,000,000 cu. ft. used during 1919 was 18 cents per 1,000 cu. ft. More natural gas probably would have been used by the industry had it not been for the regulations exercised by the producers and distributors of natural gas by which domestic users were given priority.

The by-product tar used as boiler fuel is shown in Fig. 7 (a), and, as in the case of the natural gas, was negligible when compared to the total fuel consumed. The tar is expressed in terms of coal equivalent on the ratio of one pound of coal containing 13,500 Btu. and one gallon of tar containing 168,000 Btu.

The value of the tar used as boiler fuel is shown by curve (b) of Fig. 7.

In the Pittsburgh District considerable gas is generated by the by-product coke ovens for use in open hearth furnaces. At Clairton alone more than 13,000 tons of coal are being coked daily in by-product ovens, and the capacity of this plant is now being doubled. While some of this gas is occasionally diverted to boilers because of shutdowns of furnaces and some is used for what is known as "regulator gas" to take care of slight shortages that may arise,

the quantity is so small as to be negligible in the fuel totals for boilers under consideration.

The total quantity of fuel used under the boilers of the iron and steel manufacturers in the Pittsburgh District is shown in Fig. 8. The upper curve, which represents a summation of the coal, gas, and tar used, has much the same shape as that of the lower one, which covers coal only and is reproduced on a different scale from Fig. 2 (c). There was a decided upward trend in the fuel consumption of the industry from 1911 to 1920 which corresponded generally with the increase in iron and steel production during that period.

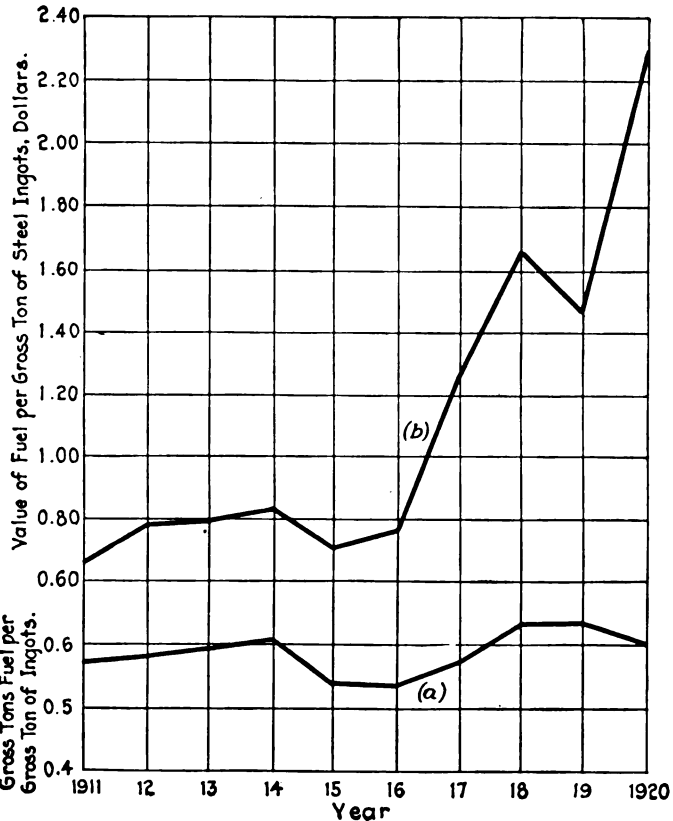


FIG. 13—Curves showing (a) quantity and (b) value of fuel (coal plus blast-furnace gas) used under boilers per gross ton of steel ingots produced in all steel works of the Pittsburgh District.

The percentages of coal and blast furnace gas used for power purposes are shown in Fig. 9. The curve is based on the coal equivalent for blast furnace gas as compared with the coal, and appears to be fairly constant in the ratio of 60 per cent coal to 40 per cent gas. This ratio is important because it shows that through the efficient use of the blast furnace gases they can be substituted for 40 per cent of the coal which otherwise would be required.

The total value of all fuels used under the boilers of iron and steel manufacturers in the district is shown by Fig. 10. Comparing this curve with curve (a) of Fig. 3 which shows the same data for coal only, it will be observed that the proportion and trend in blast furnace gas consumption is such as not to materially change the slope of the curve. It clearly brings out the upward trend in the value of power fuel since 1911. Starting at about \$5,250,000 in 1911 there was comparatively little change until 1915, when a marked increase occurred during the war years, with a decrease from 1918 to 1919 and a further con-

siderable rise until the value reached more than \$29,000,000 in 1920, or an increase of more than 500 per cent during the 10-year period.

The value of a unit of fuel is shown in Fig. 11. This value comprises coal and blast furnace gas, the natural gas and other fuels being negligible. The curve further shows the proportionate values of coal and blast furnace gas which go to make up the unit value. The unit taken is a gross ton, the blast furnace gas equivalent coal value being used as previously stated.

The percentage shown by Fig. 9 makes the blast furnace gas equivalent coal used not greatly less than the actual coal used, whereas the values in dollars show the blast furnace gas to be valued at a much smaller figure than the coal. This is a question of bookkeeping as before stated. It would seem logical that blast furnace gas should be given a higher value to make its variations more nearly correspond with the variations in coal prices. In this study, however, it was considered advisable to follow more nearly the practices of the industry.

TABLE I
FUEL CONSUMPTION, STEEL PRODUCTION, AND
GENERAL DATA ON STEEL WORKS OF
THE PITTSBURGH DISTRICT

Year.	Gross tons of fuel used under boilers.	Value of fuel used under boilers.	Gross tons of steel ingots produced.	Gross tons of fuel used under boilers per gross ton of steel ingots produced.	Value of fuel used under boilers per gross ton of steel ingots produced.	Value of one gross ton of fuel used under boilers.
1911	5,920,000	\$ 6,500,000	10,400,000*	0.57	\$0.65	\$1.10
1912	6,850,000	9,200,000	11,800,000	0.58	0.78	1.35
1913	6,850,000	9,200,000	11,600,000	0.59	0.79	1.35
1914	5,470,000	7,400,000	8,900,000	0.61	0.83	1.35
1915	6,280,000	8,300,000	11,700,000	0.54	0.71	1.34
1916	7,400,000	10,900,000	14,100,000	0.53	0.77	1.48
1917	7,830,000	17,300,000	13,700,000	0.57	1.26	2.22
1918	8,250,000	21,700,000	13,000,000	0.63	1.67	2.63
1919	7,270,000	17,000,000	11,600,000	0.63	1.47	2.34
1920	7,830,000	29,500,000	13,000,000	0.60	2.27	3.76

*Estimated.

The total tonnage of iron and steel produced in the Pittsburgh District during the years 1911 to 1920 is taken as the total weight of ingots produced during that period and is given in detail in Table I, and expressed in the form of a curve in Fig. 12. These figures were largely derived from the American Iron and Steel Institute for the later years, whereas for the earlier years a canvass was necessary to secure data covering each individual plant in the district.

It was considered advisable to use ingots as a basis of weights in connections with the production of iron and steel plants, because it was deemed impracticable to use records of finished tonnages since the latter practice inevitably involves much duplication and confusion of data.

The curve as a whole shows a decided upward trend in keeping with the trend in general production. On the other hand, the 10-year period covered is probably too brief a one upon which to base conclusions as to the proportion of increase that the Pittsburgh District is responsible for in the industry as a whole.

The quantity of power fuel per ton of steel is shown by curve (a) of Fig. 13. Variation in this

curve resulted either from the use of less desirable fuels or variations in the efficient utilization of the fuels available. Details regarding the efficient use of fuels cannot be shown in general data figures, but are worthy of special study.

The cost of power fuel per ton of steel is shown by curve (b), of Fig. 13, which represents the data of curve (a) translated into dollars and cents and indicates how the price of fuel advanced during the latter half of the period. It will be noted that in 1911 the cost of power fuel to manufacture a gross ton of ingots was 65 cents, whereas by 1920 this same figure had mounted to \$2.27, an increase of more than 300 per cent.

The data presented show two marked developments in the power phase of the industry: first, the increased load carried by each unit of physical equipment; and second, the marked increase in cost of fuel for the development of power. Many other equally interesting observations and comparisons can be made for the 10-year period, but because of the different viewpoints of those interested in the industry, the authors prefer to leave the wide variety of interpretations possible to such individuals or groups.

Lectures to Feature Power Show

All of the first two floors of the Grand Central Palace and 90 per cent of the space on the third floor has been contracted for by exhibitors at the Fourth National Exposition of Power and Mechanical Engineering to be held from November 30 through December 5, 1925. This is ample evidence that the coming Power Show will present more than its usual quota of the newest devices and apparatus that obsolete rapidly the power plant of today.

One of the features of the show will be a series of lectures on the important developments in power and mechanical equipment during the preceding year. These are planned primarily for students, but will be of general interest to mechanical engineers who wish to bring up to date their information on the rapid development in all phases of mechanical engineering. The list of topics which have been selected for presentation by leading authorities includes: Steam Prime Movers, Oil and Gas Engines, Steam Boilers, Modern Industrial Power Plants, Hydraulic Machinery, Machine Tools, Heating and Ventilating Equipment, Mechanical Refrigeration, Mechanical Power Transmission, Standardization, Materials handling in the Power Plant, Materials Handling in Industry, the Steam Locomotive.

The lectures will be scheduled to avoid conflict with the sessions of the annual meetings of the American Society of Mechanical Engineers and the American Society of Refrigerating Engineers which will be held in New York during the week of the Power Show.

As most of the lectures deal with subjects that will be well represented by exhibits at the Power Show, the combination of lectures and exhibits will furnish a valuable opportunity for securing available information on the important types of mechanical equipment. The Power Show has great educational value and the plan of lectures with the opportunities to study several concrete examples of the apparatus dealt with in each lecture provides means for making this educational value available to those who use the Power Show for that purpose.

Electric Gray Iron Castings

One of the most interesting, if not the most interesting, exhibit at the convention of the American Foundrymen's Association held this year at Syracuse, New York, was that of a small electric furnace in actual operation producing gray iron castings.

The electric furnace is generally known for the production of high quality alloy steels, tool steels, and steel castings, but its application to the field of gray iron is something that has not heretofore been markedly brought to the attention of foundrymen. As a matter of fact, this was the first time that electric furnace gray iron castings have ever been poured within a Convention Hall.

Some two years ago at the convention, steel castings were poured but the Syracuse Convention marked the initial effort in the practical operation of a furnace on gray iron production within a Convention Hall.

The practical operation of the furnace was made possible through the co-operation of a local foundry in Syracuse, who had their men make up the molds and who took the sand-blasted castings and after ma-



Hardly the appearance of a gray-iron foundry, but the Pittsburgh Electric furnace erected at the Foundrymen's Convention and Show at Syracuse demonstrated the fact by commercial production.

chining, used them on their regular orders. The castings were made from an all scrap charge and the chief difficulty in the operation was the fact that due to the temperature of electric iron, the common quality of cupola foundry sand used in making up the molds, was burned on the surface rather badly on the first few heats.

The castings on machining proved to be very close grained and soft, threading and facing operations going through on the regular production schedule in the machine shop along with the cupola castings. The castings were sand-blasted and snagged at the show through the courtesy of exhibitors who had sand-blast and grinding wheel equipment in operation.

We believe that an operating exhibit such as this is of real value and if one may judge from the crowd which surrounded the show, was of exceptional interest to the foundrymen attending this year's convention at Syracuse.

WITH THE EQUIPMENT MANUFACTURERS

The Sykes Herringbone Gear Generator

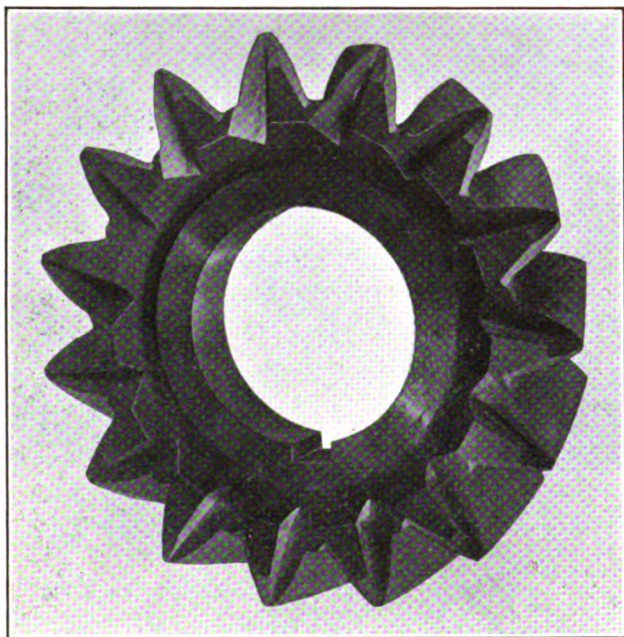
THREE years ago the Farrel Foundry & Machine Company, Buffalo, N. Y., acquired the American and Canadian Patents relating to the Sykes Gear Generating machines. At the time the Patents were acquired four gear cutting machines of various sizes to cover the whole range of herringbone gear requirements, were brought over from England. These machines comprised the initial equipment for producing the now well known Sykes Continuous Herringbone Gears. Within two months after the installation of these machines the demand for their product became so large that the Farrel Foundry & Machine Company decided to build and install an extensive equipment of Sykes Gear Generating machines. At the present time there are fifteen of these machines in constant

Reducing Units, up to medium sizes which have been developed concurrently with the gear cutting machines. Subsequently the Foote Bros. Gear & Machine Company, Chicago, purchased a similar equipment. Therefore at present the Sykes Herringbone Gears are being produced on the Pacific coast and in the middle west in addition to Buffalo, N. Y.

Several large users of Herringbone gears in various parts of the country have expressed a desire to install their own Sykes gear generating equipment, with the result that the Farrel Foundry & Machine Company, have now decided to put on the market the whole range of gear cutting machines, and we are thus able to give a description of these interesting machines.

The most interesting features connected with the Sykes machines is the method of cutting the Herringbone or Double Helical teeth, having the right and left hand portions of the teeth joined at the centre of the face without any clearance whatever for the cutting tools. Many users of these gears, and others who have inspected them, have been at a loss to understand how it is possible to machine the teeth in this manner. It seems to the average mechanic to be impossible to machine a groove or tooth space which finishes abruptly in solid metal. Several instances are on record where those interested in this apparently impossible achievement have actually cut the gears to pieces in order to find a joint at the centre of the teeth which they thought must exist.

Like many apparently difficult machine shop operations the production of the Sykes Double Helical Continuous Tooth Gears is very simple when it is seen. Unlike many unusual machine shop operations however, it is not easy to describe, but we think the following remarks, with the aid of the accompanying sketches will explain how the teeth are cut sharp to a point. It is first necessary to explain that the cutters used are what are known as pinion type cutters, that is to say they are themselves gears having teeth of involute contour, just the same as the cutters used in the well known Fellows Gear Shaping Machines. For cutting Single Helical and Double Helical gears it is of course necessary to use helical cutters. Fig. 1 shows a cutter as used in the Sykes machines. Fig. 2 shows diagrammatically the cutters in the process of cutting a gear blank, and also shows how the generation of the teeth proceeds. These cutters, as will be seen, are mounted on the gear cutting machine with their end cutting faces facing each other, both cutters are mounted suitably on one reciprocating carriage, and therefore, as they reciprocate to and fro one cutter cuts when the reciprocating is in one direction, and the other cuts when the reciprocation is in the opposite direction. The construction of the machine insures that each cutter ends its stroke when its cutting edges are at the centre of the face of the blank. It may thus be assumed that when one cutter reaches



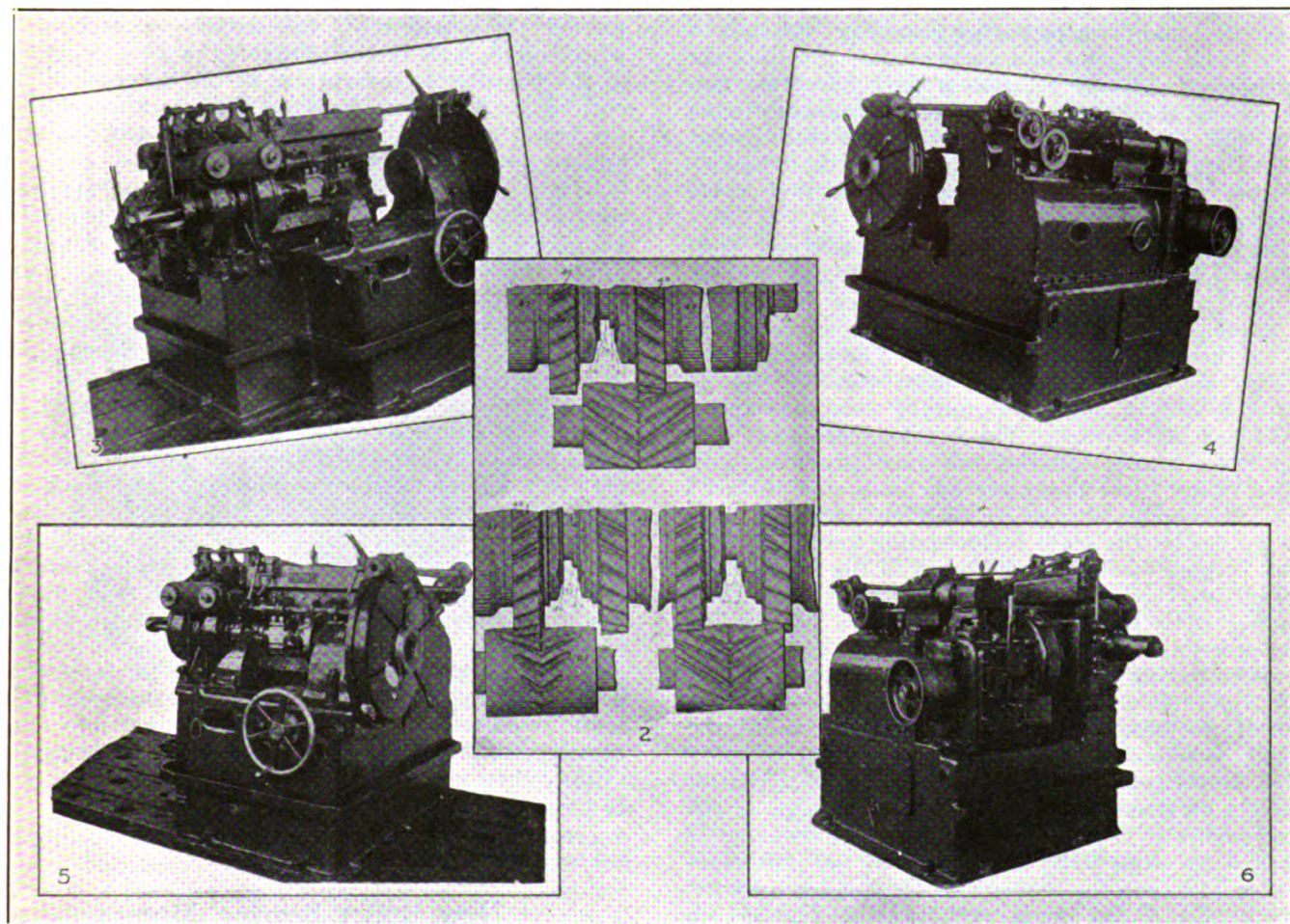
operation at the Buffalo Plant, five of them are of the largest size; they will cut gears up to 18 in. diameter.

But this extensive equipment is not sufficient to meet the demand for the gears which constantly increases, and extends to a great variety of industries. Some few months ago the Farrel Foundry & Machine Company's executives made a careful survey of the probable demand for the Sykes Herringbone Gears, and as a result decided that it would be desirable to place some of these machines in localities remote from Buffalo, so as to deal more promptly with orders and thus give better service to those using or contemplating using the gears. It was decided to install a machine on the Pacific coast first, and as a result the Link Belt Meese-Gottfried Company, San Francisco, purchased a complete equipment to enable them to produce Sykes gears, and the whole range of Gear

the end of its cutting stroke it leaves a burr or chip, and that the other cutter when completing its working stroke removes this burr and leaves another one. This is actually what happens, but there is another interesting and very important feature which makes this method successful. The cutters not only reciprocate and twist during their reciprocation so as to generate the helices, they also slowly revolve in unison with the wheel blank, thus generating the teeth contours. This generating feature happens to result in finishing the apices of the teeth in a perfect manner. It can be easily understood that if one cutter merely removed the burr left by the other cutter and in its turn left a burr, there would be some burr finally left. This generating action, however, of these cutters makes

to join the Farrel Organization, and during the past three years a number of improvements have been developed. The smallest size machine known as the No. 1½ which is illustrated in Figs. 3, 4, 5, and 6 is representative of all the other sizes, excepting the largest size known as No. 12, with the exception that machines at present being constructed will have a device for automatically controlling the tooth depth to be cut. Further reference to this device will be made hereafter.

Fig. 3 shows a front view of the machine, the cutters can be seen clearly in this view. Fig. 4 is a front view of the machine taken from another angle. Figs. 5 and 6 are rear views. In these views the driving pulley is shown, this pulley is mounted on a shaft



it impossible to leave any blemish provided the machine is properly adjusted, because as each cutting tooth slowly revolves out of engagement with the tooth space it has cut, it cuts a chip which tapers off to an infinitesimal thickness, and this has the effect of cleaning out the corners perfectly.

As already stated above it is difficult to describe clearly this very interesting feature, but it is hoped that the following description together with the illustrations of the actual gear cutting machines will make everything clear.

When the Farrell Foundry & Machine Company, commenced building these machines in the Buffalo Plant they were in a highly developed condition, nevertheless it was recognized that developments would be made, and arrangements were made for the inventor and designer of the machine, W. E. Sykes,

which projects from a four speed gear box. This gear box is made as a unit and mounted on one end of the machine. On the side of the gear box opposite to the driving pulley is the crank disc which serves to reciprocate the main sliding carriage or ram which carries the cutter brackets, as seen in Figs. 3 and 4. The four speeds provided by the gear box can be changed selectively by the levers shown in Fig. 5. All the gears in this gear box have Sykes Herringbone Teeth, with the exception of a pair of bevel gears which are arranged to connect a vertical shaft which projects at the top of the gear box, and serves to drive the generating feed mechanism. It connects through bevel gears and a safety clutch to another smaller four speed gear box which controls the rotating feed mechanism. It has two power outlets, one connects to the cutter index worm wheels, and the other to the main index

worm wheels. In the latter train of shaft and gear connections is interposed the only train of change gears in the machine, these are for giving the correct ratio between the cutter spindles and the main work spindle, and they thus provide means of varying this ratio in order to cut any desired number of teeth. The driver change wheel is arranged to have the same number of teeth as there are in each cutter, and the driven change wheel the number of teeth desired in the wheel blank to be operated on. Therefore there are no complications as regards the determination of the proper change gear ratio.

The crank disc previously referred to is made integral with its shaft from a solid steel forging. It carries an adjustable steel crank pin so that the exact stroke required is easily obtained. The crank pin drives the main reciprocating carriage through a square block engaging in a vertical slot, and thus the reciprocating carriage receives a pure harmonic motion causing the cutters to decelerate uniformly from the middle of the stroke to the end of the stroke. This is important because it is necessary that the cutters stop positively and without jar at the centre of the face of the wheel blank.

The cutters are carried on case hardened steel spindles which are accurately ground and lapped. The bearings which carry these spindles are also of case hardened steel, and they are fitted most accurately both on the journals and end faces. The spindles and bearings are lapped together most carefully so as to provide only a minimum running clearance and a perfect bearing surface. The brackets or heads carrying these cutter spindles are each provided with flanged bases, these bases are machined and surfaced to fit into guides formed in saddles which in turn fit in guides on the main reciprocating carriage. The guides formed by the flanged bases of the cutter head brackets and saddles already mentioned, have their engaging surfaces at an angle with the axis of the cutter spindles. This is part of the relieving mechanism which has the function of withdrawing each cutter away from the wheel blank prior to the commencement of the return stroke. The angularity of the guides combined with the movement longitudinally of the saddle, relative to the bracket causes the latter to have a movement at right angles to the axis of the cutter spindles. The correct amount of movement is governed by stops fixed at the end of the aforementioned guides, and the movement is engendered by the reciprocation of the main reciprocating carriage in conjunction with a movement imparted by some rotating cams operating on cam rollers. These can be seen in the two front views Figs. 3 and 4.

It will be observed that in the relieving motion each cutter must have independent movement because whilst one cutter is withdrawing from the work, the other cutter must be approaching the work. Actually each cutter bracket is independent of the other one except that it receives its reciprocating motion from the main reciprocating carriage. Each cutter receives its twisting motion, necessary to obtain the helical trace of the cutter teeth, from helical guides which can be observed in the two front views. The cutter furthest away from the cutter index gears and nearest to the main index wheel, is controlled so far as its twisting and rotating movements are concerned, by the cutter index gear furthest away from it. This requires the shaft connecting this particular cutter

spindle with its helical guide to pass through the other cutter spindle and the other helical guide. Therefore the cutter spindle to the left in the front view is hollow and connects to the helical guide nearest to it.

The housings containing the cutter index worm wheels must move at right angles to the axis of the worm wheels so as to keep in true alignment with the cutters during the relieving motion. This is only a very slight movement and it is controlled by the same mechanism that operates the cams on the cutter brackets.

The saddles which carry the cutter brackets on the reciprocating carriage are made adjustable in a similar manner to the tool boxes on the cross rail of a planing machine. This construction provides means of adjusting the position of the cutters relative to the wheel blank, and further provides precise adjustment of the position of the cutters at the reversal of their cutting strokes, thus enabling the operator to obtain the beautifully finished tooth apices so much admired and so much commented upon.

There is one other important adjustment necessary, it is obvious that the cutters must be adjusted in a circular direction so as to get the teeth in each cutter directly opposite the teeth in the other cutter so as to ensure that they will register accurately at the centre of the wheel face. This adjustment is obtained by declutching the gears connecting the two cutter index worms, thus permitting either of these worms to be turned by hand independently of the other one. The connection and disconnection is made by finely serrated clutch teeth which are cut in rings of large diameter. These clutch teeth being on the work shaft provide very fine adjustment of the cutters because of the large ratios of the cutter index worm gear. Each cutter may be adjusted to a limit as fine as one ten-thousandth of an inch, and the adjustment may be made while the machine is running, in fact it is desirable to make it only when the machine is running. The actual gauging of the gears, both for teeth thickness, tooth depth, and for position of the apex of the teeth, is all done after the machine is put into operation by the simplest possible means. A description of the actual gauging operations does not come within the scope of this article.

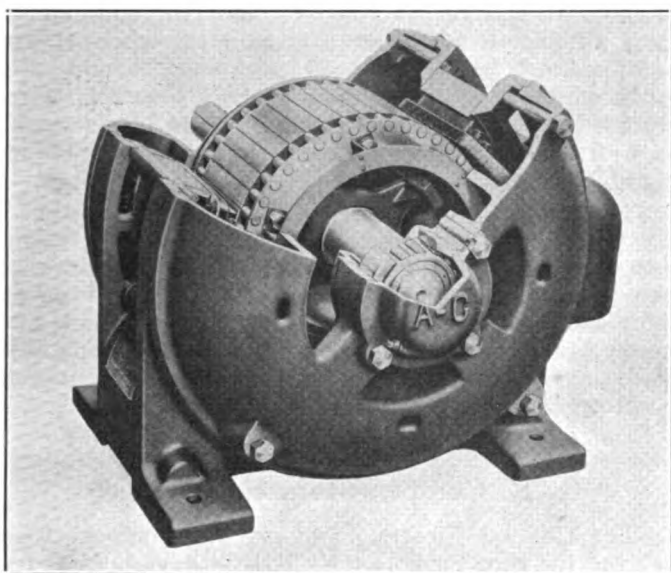
(To be continued in the December Issue)

New Roller Bearing Motors

After two years of experimental and development work, the Allis-Chalmers Manufacturing Company, Milwaukee, Wis., has placed on the market a complete line of 25 and 60 cycle squirrel cage and slip ring induction motors equipped with Timken tapered roller bearings. This is in addition to the company's well known line of sleeve bearing motors. The Timken bearing was selected only after very careful consideration of the many questions of design and operation. After designs of bearings and mountings had been made, a number of motors of various sizes were built and tested under actual operating conditions of belt, gear, chain and coupled drives, a sufficient length of time to insure satisfactory service before the line of motors was offered to the trade. The Timken tapered roller bearing has been used because of its ability to withstand continued heavy radial and thrust loads without undue heating or appreciable

wear. It is particularly suited to heavy service and will operate satisfactorily at the high speeds found in the general purpose induction motor. Because of the rolling action of the bearing, there is practically no wear so that the factory adjusted air gap is maintained indefinitely, eliminating any possibility of the rotor striking the stator.

The important question of lubrication is greatly simplified as grease is used, requiring very infrequent attention on the part of the operator. This is a very important point, because it has been found from experience that a great many motor troubles can be traced to improper lubrication. The bearings have grease tight enclosures, effectively excluding dirt or abrasive matter that might cause undue wear of the bearings. The mounting of the bearings is very simple, being only a light press fit for both the cone and the cup, and not requiring the use of a lock nut or other means of holding the races in place. This also facilitates the removal of the bearings whenever necessary.



The Timken tapered roller bearing is nationally known, and has been used extensively in the automobile field for many years, where its operation has proven very satisfactory, as many automobile owners know. The engineering, manufacturing and service facilities of the Timken Roller Bearing Company are now being directed to the field of motor applications, assuring results as satisfactory as in the past in other fields.

In addition to the bearings, special attention has been given to many other features of design of this line of motors. This motor has to meet the many severe conditions found in its application to the various types of machinery manufactured by the company. The frame is made of steel with feet cast integral, to withstand shocks encountered in use with the company's crushers, grinders and other machinery. In applying the motors to the company's centrifugal pumps, very often severe conditions of moisture are met so that the coils are thoroughly insulated and baked in a water-proof varnish. In saw mills, flour mills and cement mills, motors must operate in very dusty and dirty places, so that the scheme of ventilation must successfully meet these conditions. The openings in the housings and frames for

ventilation are so placed in vertical planes that falling objects cannot enter the motor. The roller bearing motor is particularly adapted to many applications because the overall length is considerably less than for a sleeve bearing machine. Inasmuch as this line of motors must meet the exacting requirements of application to the company's own machinery, the general buyer benefits because these special features are incorporated in the manufacture of all the motors produced by the company.

This motor equipped with Timken tapered roller bearings can now be obtained in all ratings, 25 and 60 cycle, 200 hp. and smaller.

A Worm Reduction Gear for Vertical Shaft Drive

Worm reduction gears, in addition to reliability, compactness, simplicity and efficient operation, also have the valuable peculiarity that the driven shaft is at right angles to the driving shaft. While the driven shaft is horizontal, this permits the motor to be located out of the way, alongside the machine, instead of projecting out across aisle space. For vertical shaft drives, it is even more convenient, since it does away with bevel gears and vertical belts, which are always more or less troublesome. It is ideal for vertical agitators, autoclaves, mixers, chaser pan mills, etc.

The accompanying photographs show a worm reduction gear for vertical shaft drive recently developed by the De Laval Steam Turbine Company of Trenton, N. J. The gear casing supports the worm bearings and also the lower bearing of the driven shaft, while the upper shaft bearing is held by the casing cover. The oil is carried at such a level that the worm and gear wheel dip into it, thus insuring copious lubrication. The lower wheel shaft bearing is always immersed in oil and has spiral grooves to insure circulation of the oil.

To provide oil for the upper wheel bearing and thrust plate, a small reciprocating oil pump is incorporated in the casing cover. The plunger of the pump projects downwardly against a cam, which may be seen in one of the illustrations just outside of the thrust plate of the bearing, the latter being recognizable by the two oil grooves. The rotation of the cam actuates the plunger, which, by means of ball check valves, draws in oil through the suction pipe projecting from the under surface of the cover down into the oil in the casing. Suitable filling and drainage openings, together with a try-cock, provide for control of the oil level. With this type of speed reducer, inspection of the oil levels is about the only attention required.

For larger size reductions, where the worms run at fairly high speeds, it is not desirable to immerse the worm and wheel on account of fluid friction, and a positive pressure oiling system is therefore used to feed oil to all the bearings and to the worm threads and gear teeth at the contact points. A full line of these drives is made and drives can be had with the shaft extending either upward or downward.

The Ohio Electric & Controller Company, Cleveland, Ohio, wish to announce the appointment of Mr. R. E. Bock, as their district manager, 53 West Jackson Boulevard, Chicago, Illinois.

Roller Bearings on Ingot Buggies

Nineteen representative steel plants, during the past year, added 1,119 Hyatt equipped ingot mould and charging box cars to their open hearth plants.

There are now over 6,000 Hyatt equipped ingot and charging cars operating in the leading plants throughout the country. Each Hyatt equipped car serves to assure economical and efficient transportation of ingots and scrap; a definite decrease in upkeep, maintenance and lubrication expense, and contributes to a general reduction in the cost of producing steel.

Hyatt bearings have been found to be applicable both to present existing cars and to new cars which are built to replace those that are worn out and scrapped.

Several plants during the year have found existing equipment to be in such shape that a definite program for replacement is necessary, and all ordinary plain bearing equipped open hearth cars are being scrapped and replaced with up-to-date Hyatt equipped cars of new design, embodying other features tending to reduce upkeep and maintenance, accident hazards, etc., namely, automatic couplers, rolled steel wheels, cast steel car bodies, and heat treated axles which better stand up under the shocks encountered.

On car equipment two large plants which up to the present time have operated charging cars of the built up structural steel variety have discarded these cars completely for new cars of the cast steel body type design. In some plants the smaller type of car carrying three charging boxes is still used, while the general trend is to the car which will carry four boxes. This four-box type of car enables a plant to operate with 25 per cent less cars, obtaining the same capacity of charging boxes and the cost of 25 per cent less four box cars is less than the cost of the increased number of three box cars, even when comparing the cast steel type of new design car to the structural type of old design.

During the year 1924 several plants embarked on programs which increased rolling capacity in the way of entirely new mills, and on a pronounced majority of these new mill installations, Hyatt bearings have been incorporated on mill tables.

In addition to the reduction in motor sizes which is made possible by the installation of Hyatt roller bearings on mill tables compared to ordinary plain bearings, it was also found possible in many instances that the increased cost of Hyatt bearing installation over brass was little, if anything. Hence, not only was the first cost of the Hyatt equipped tables reduced under that of brass, but the saving in motor horse power, both at the very outset and what will be obtained after the equipment is in service, means a substantial decrease in the cost of the table equipment.

The steel mill type of Hyatt bearing especially adaptable and developed for severe rolling mill table service has now been operating on heavy mills for the past three years, and has proved its ability to stand up under the conditions encountered.

Other equipment where bearings are inaccessible for frequent lubrication have been built to incorporate Hyatt bearings and thus be assured of the positive oiling action of the helically wound Hyatt rollers in equipment such as blast furnace bull wheels and skip cars, blooming mill manipulator rollers, etc.

Where speeds are high and lubrication often difficult resulting in frequent bearing replacements, even

though plain bearings are water-cooled, such as hot and cold saws, Hyatt bearings have proved their ability to outlast any type of plain bearing yet devised, and have been added to the latest designs of hot saws where the motor armature is assembled directly on the same arbors, consequently the Hyatt bearings acting both as motor bearings and as saw bearings.

Certain types of sintering machines which employ pallets and a considerable number of wheels, which are open to the abrasive flue dust which is ever present, have been made to operate more economically and with a better enclosed type of wheel, with the Hyatt bearings incorporated, and during the past year several such sintering machines have been so equipped.

The design of housing to enclose the Hyatt bearing permits of a construction which practically insures the exclusion of scale, water, and other foreign matter which generally gets into ordinary bearings and causes frequent and costly delays and replacements.

Gear reductions, crop conveyors, electric motors, cranes, ore bridges and other important equipment, have all proved to be more economical when Hyatt equipped.

In wire plants, during the year 1924, over 2500 wire trucks, Hyatt equipped have been placed into service, as well as several wire block stripping cranes being equipped in a similar manner.

The group driven wire benches which have been Hyatt equipped in some plants for the past eight years are still giving the same dependable service as when originally incorporated, and the new type of individual driven wire blocks, over 100 of which are in operation at one leading wire plant, are completely Hyatt equipped, and have proved the value of incorporating Hyatt bearings into this equipment.

G. E. Compensators Redesigned

The General Electric hand starting compensators bearing the type designation CR-1034 have been redesigned. These compensators are for use on a.c. circuits for starting squirrel cage induction motors.

Temperature overload relays have been incorporated in the compensator, replacing dashpot overload relays. In one of the sizes multiple rated auto-transformer coils are used instead of the single rated variety. The redesigned compensators also include an improved push-button mechanism, containing an attachment for resetting the temperature overload relay.

Closer overload protection is expected with the newer type of relay. The multiple rated auto-transformer coils, where used, permit the use of one compensator for several horsepower ratings for a given voltage. The incorporation of the relay resetting function in the push button simplifies the operation of the device, making it unnecessary to open the compensator for this purpose.

Effective November 1st, Mr. John H. Bode, vice president, Mackintosh Hemphill & Company, has resigned to accept the presidency of the Wellman-Seaver-Morgan Company. Mr. C. V. Wilt has been placed in charge of operations in the capacity of assistant to president, and Mr. A. H. Baum as second assistant to president of Mackintosh Hemphill & Company.

TRADE NOTES AND PUBLICATIONS

Mr. E. Von Maltitz, formerly Metallurgical Engineer of the Illinois Steel Company, has associated himself with H. A. Brassert & Company, Consulting Engineers, to take charge of their work in the field of special steels. Mr. Von Maltitz has had a wide experience in this branch of the industry, both in this country and abroad. After graduating in Berlin he was for two years assistant superintendent of the open hearth and Bessemer departments of the Prager Iron & Steel Company in Austria. Following this he became open hearth superintendent of the Dominion Iron & Steel Company, in which position he remained for four years. He then became metallurgical engineer of the Illinois Steel Company, spending eight years in that capacity, first at the South Chicago plant and later at Gary. In the intervening years he was general superintendent of the Hess Steel Corporation, producers of alloy and tool steels, also consulting engineer of the Witkovitz Iron & Steel Company in Austria.

The Robert June Engineering Management Organization of Detroit has acquired control of the Electric Flow Meter Company at Kansas City, Mo., formerly the Hyperbo-Electric Flow Meter Company of Chicago, and will henceforth operate the business under its own management with executive offices at 8835 Linwood Avenue, Detroit, Mich. Robert June becomes president of the company; J. M. Naiman, formerly general manager, becomes vice president, consulting and chief engineer, with Major W. W. Burden of the Robert June Organization as treasurer.

Hayward Buckets

Two very descriptive bulletins covering the various phases of bucket operation have just been issued, "Orange-Peel Buckets," Bulletin No. 655, and "Class E Clamshell Buckets," Bulletin No. 650, by the Hayward Company, 50 Church Street, New York City. Many views of specific applications of both type buckets are shown, and the various weights and powers are indicated.

The Hayward orange peel buckets covered in this bulletin are: Standard, Extra Heavy Standard, and Multi-Power. They are recommended and widely used for dredging, excavating, sewer construction, for removing overburden, and for various classes of work requiring actual digging or loosening of material. Each is of exceptionally sturdy design, made to cope with the severest usage in the work for which it is recommended.

These three types of buckets are similar in design and construction, and operate in the same manner. The Extra Heavy Standard orange peel bucket follows the general lines of the Standard, but is made much heavier in every part to withstand harder bucket service. It is the heaviest type of four-blade Hayward bucket, with the exception of the Multi-Power and special buckets designed to meet unusual digging and rehandling needs.

Two distinct types of bowls or trays are used for the Class "E" bucket: the curved or "Regular" type and the flat bottomed or "Ore" type. The first is used for handling very loose materials like coal where quick discharge is necessary, and for very sticky materials like clay. The second is for firmer or heavier materials, such as gravel, crushed stone, sands, ores and natural excavation. The flat bottom of the ore bowl decreases the friction encountered in filling the bucket with these materials. The ore bowl bucket is a more powerful digger and, therefore, fills beyond rated capacity to a much greater extent than the regular bowl.

The highest grade flange steel is used for the carefully formed plates and arms of the bowls. The sides and backs are protected along the cutting edges by a shoe which extends entirely around the bowl. This shoe is recessed at the rear edge to receive the back and side plates, and across the front is beveled to a sharp edge. A large amount of solid metal extends from the cutting edge back to the recess which thus provides for a great amount of wear. For ordinary work the shoes are made of rolled carbon steel, but for handling abrasive materials manganese steel is suggested and can be supplied at slight additional cost.

In the heavier types of Class "E" buckets, newly designed cast steel corner and center brackets are used. These add to the structural strength of the bucket and tend to reduce upkeep.

Westinghouse Promotes Executives

Edward D. Kilburn, Vice-president and General Manager of the Westinghouse Electric International Company, and Walter S. Rugg, General Sales Manager of the Westinghouse Electric and Manufacturing Company, were named Vice Presidents of the latter company at a recent meeting of the Board of Directors in New York. At the same time Richard B. Mellon of Pittsburgh, President of the Mellon National Bank of that city and a brother of A. W. Mellon, Secretary of the United States Treasury, was elected a director of the Company. Mr. Mellon will fill the vacancy caused by the death of William McConway, formerly President of the McConway & Torley Company.

Messrs. Rugg and Kilburn will take charge, respectively, of the engineering and sales activities according to announcement by Vice-President F. A. Merrick, general manager of the Company.

Vice-President H. D. Shute, aside from the direct operation of the sales department which will be handled by Mr. Kilburn, will retain his direction of the broad commercial activities of the company, including especially customer relationships.

Vice-President H. P. Davis, formerly in charge of engineering and manufacturing activities as applying to the strictly electrical portions of the company's business, will have direction over the entire manufacturing activities of the company and, in addition, will have direction on the general features of the radio business including broadcasting.

BY-PRODUCT AND CHEMICAL NEWS

Coke Production and Consumption

At the last meeting of the German Gas Association, Dr. K. Bunte of Karlsruhe presented a long paper on this subject. This was reproduced in *Das Gas-und Wasserfach* for December 13, 20 and 27. The heads under which Dr. Bunte dealt with this subject may be briefly summarized as follows, the paper dealing generally with the need for producing coke of good quality, and the means for doing so:

1. Coal should be carbonized as fresh and as soon after delivery as possible. The extent to which this can be practiced naturally depends very largely on the storage facilities.

2. Coal should be as small and as even in size as possible before being introduced to retorts, the degree of fineness being limited, of course, by the necessity of the charge being porous to gas. Naturally high-ash small coal, or that which is broken in transport or handling, is not to be compared with properly crushed coal.

3. Coals rich in gas and bitumen should be mixed with poorer sorts. The improvement in coke quality must then be regarded as compensating for the reduced gas output, and for the cost of coal breaking and mixing.

4. Mixtures should be kept as even as possible as regards various kinds and sizes of coal, with the object of avoiding the formation of cracks.

5. Slow carbonization should be aimed at, with even temperatures not worked up too high. In this connection, it is important to remember that the slower carbonization contemplated is not necessarily achieved by the longer carbonization periods required by coal which contains much rough small. The striving after high oven efficiencies by means of high temperatures may often lead to undesired results in other directions.

6. The finished coke should not be allowed to stay too long in the retort. For water gas production, it is nowadays often subjected to further heating, but even if this process does tend to lower temperatures in the retort, no doubt changes continue to take place in the coke substances, which lead to splitting, cracking and friability.

7. According to the purposes for which the coke is required, attention must be paid to easy ignition and ready combustibility.

8. Careful handling in quenching and dispatch is essential.

9. The lowest possible water content should be aimed at moisture in coke, even when prices are reduced accordingly or sale is by measure, often prejudices customers in favor of a by-product coke which may be bad in other respects and really less suited for their purposes, but which is dry.

In Dr. Bunte's opinion, in order to maintain coke sales and prices, good coke must be produced, and quite considerable costs in the way of coal, plant and wages are justified to this end. Any considerable variation in the relation between coal and coke values might, in certain circumstances, justify even far-

reaching technical changes. The price of coke is the primary factor in the relative cost of water gas to that of coal gas, and, in the present coal situation in Germany, an important factor in determining the nature and quality of the town gas supplied. Falling coke prices may, in certain circumstances, even demand the consideration of a resumption of carburization, in order to be able to increase water-gas supply. The question of central producers with low-grade fuel or separate producers with good coke depends also very largely on the state of the coke market. In every way, coke quality is intimately connected with the whole question of gas-supply development.—*Gas Journal*.

American Refractories Institute

The American Refractories Institute, which is to the manufacture of fire resisting materials what the Iron and Steel Institute is to the iron and steel industry, concluded on October 29th a two days' session at the Waldorf-Astoria. The institute was founded only one year ago as an outgrowth of an Association of Manufacturers of Refractories which had been in existence about nine years. More than one hundred members, coming from as far away as Texas and California, were in attendance. That the industry has attained important proportions is evidenced by the fact that the yearly production of refractories—fire-resisting materials—has reached a value of \$75,000,000.

William C. Sproul, formerly governor of Pennsylvania, and chairman of the board of the General Refractories Company, is president of the institute. On Wednesday was held a meeting of the board of directors. Thursday was devoted to the reading and discussion of a number of papers, many of them technical, dealing with problems connected with the manufacture and use of heat-resisting materials.

In addition to the opening address by Governor Sproul, these included talks by the following: J. D. Ramsey, president of the Elk Fire Brick Company of St. Marys, Pa., "The American Refractories Institute and Its Aims"; "Research in Refractories," by W. A. Carter, of the Detroit Edison Company; "Service Conditions in Boiler Furnaces as Affecting Refractories," by Ralph Sherman of the U. S. Bureau of Mines, Chicago, Ill.; "Shrinkage of Diaspore," by S. M. Phelps, Fellow of the Mellon Institute, University of Pittsburgh; "Firebrick Specifications," by J. S. McDowell of the Harbison-Walker Refractories Company, Pittsburgh; "Refractories Fellowships at the Mellon Institute," by N. C. Booze, Senior Fellow of the Mellon Institute of Industry and Research. In addition, a report of the research committee was made by P. S. Kier, chairman of the Kier Firebrick Company, Pittsburgh, Pa., and W. H. Patchell, past president of the Institute of Mechanical Engineers (England) delivered an address on "Refractories."

The annual dinner of the institute took place in the Waldorf apartment of the Waldorf-Astoria on Thursday, speakers being Governor Sproul, who presided; George Wharton Pepper, Charles M. Schwab, Elisha Lee, vice president of the Pennsylvania Railroad, and General T. Coleman du Pont.



Open Hearth Operators Meet

Co-operation and Standardization Keynotes of Metallurgical Meeting in Cleveland

FIFTY prominent open hearth men held their second general meeting in Cleveland, October 13-14-15. The first and preliminary meeting, held during April in Pittsburgh, accomplished its purpose of bringing into closer relationship these practical men, all like-minded on a difficult problem.

At this second meeting no technical papers were presented, the gathering preferring to confine its interests to discussion of operating conditions and technique at their various plants. Prevailing tendencies in furnace lines, ports, burners for oil and gas, automatic controls and refractories, were touched upon and analyzed.

President J. V. W. Reynders of the American Institute of Mining and Metallurgical Engineers delivered the opening address. Kent Harrison, Donner Steel Company, Buffalo; W. A. Maxwell, Jr., General Superintendent, Inland Steel Company, Chicago; Kenneth McCutcheon and G. D. Trainter, American Rolling Mill Company, Middletown, Ohio; J. J. Bowden, Laclede Steel Company, Alton, Ill.; Carl W. Pierce, Mansfield Sheet & Tin Plate Company; W. E. Buck, National Enamel & Stamping Company, Granite City, Ill.; R. J. Cain, Bourne-Fuller Company, Cleveland; C. B. Collingwood, Stanley Works, New Britain, Conn.; James R. Stuart, Colorado Fuel & Iron Company, Pueblo, Colo., and others were all active and enthusiastic.

Co-operation and standardization were the keynotes struck by the meeting. At its conclusion each operator left with the impression of something accomplished. The idea of assembling under the association seal drawings of late designs of various typical furnaces in photostat form for co-operative reference was favorably received.

E. A. Whitworth presided and L. B. Lindermuth serves as secretary.

Eastern States Blast Furnace and Coke-Oven Association Meeting

The fall meeting of the Eastern States Blast Furnace and Coke Oven Association was held in Buffalo, N. Y., on October 8th, with 150 members and guests present.

Throughout the day the men visited various blast furnace and coke plants in and around Buffalo and in the evening the dinner and meeting was held at the Hotel Lafayette.

A paper on "Operating Experiences with the Narrow Becker Type Oven" was read by Mr. Charles R. Meissner, superintendent of the By-Product Coke Plant of the Weirton Steel Company. These ovens were the first commercial battery placed in operation for making blast furnace coke and the comparison of the design and operating results of the initial installation with later plants of the same type aroused considerable interest.

Mr. Meissner's paper was discussed by Mr. C. A. Meissner, chairman of the Blast Furnace and Coke Oven Committee of the U. S. Steel Corporation; Mr. Joseph Von Ackeren, of the Koppers Company; Mr. Caleb Davies, assistant general superintendent of the Republic Iron & Steel Company; Mr. William A. Haven, superintendent of the Northern Blast Furnaces, Republic Iron & Steel Company, and Mr. C. L. Wagoner, general superintendent of coke ovens, By-Product Coke Corporation of Chicago. Mr. Dan M. Rugg, newly elected president of the Association, presided at the meeting.

NEWS OF THE PLANTS

The Atlas Alloy Steel Corporation, Dunkirk, N. Y., is making extensions in the equipment facilities at its local mill, including the installation of considerable machinery heretofore located at the Ann Arbor, Mich., works of the company. This last noted plant will be entirely dismantled and operations discontinued. It is expected to develop extensive increase in output at the Dunkirk mill to provide for the change.

The Eastern Steel Company, Pottsville, Pa., has completed plans and will proceed with the construction of a new merchant bar mill at its plant, designed for considerable increase in present output. The rolling mill will be one-story, steel frame, estimated to cost in excess of \$150,000, with equipment. The company is also reported to be arranging for other expansion.

The Conemaugh Iron Works, Inc., Blairsville, Pa., is said to have plans nearing completion for the rebuilding of the portion of its local plant recently destroyed by fire with loss estimated in excess of \$175,000, including equipment. The reconstruction is expected to cost close to a like amount.

The Carnegie Steel Corporation, Pittsburgh, Pa., is arranging for the early erection of the proposed new 12-inch bar mill at its McDonald works, near Youngstown, Ohio, following out its expansion program at this plant. Work is now in progress on a 14-inch mill unit, to be completed early in the coming year. A new 10-in. mill has recently been completed and placed in service. These three mills will make a total of nine bar, band and hoop mills at the McDonald plant. The estimated cost of the new 12-inch unit has not been announced.

The Wisconsin Steel Works of the International Harvester Company, 2701 East 106th Street, Chicago, Ill., has completed plans for a new addition to its plant and will place the work under way at an early date. The expansion will consist of a one-story merchant bar and steel mill, to be known as Plant No. 5. It is estimated to cost in excess of \$300,000, with machinery. W. Forstrom is company engineer, in charge of the project. The building erection will be carried out by the Dwight P. Robinson Company, New York.

The Glasgow Iron Company, Pottstown, Pa., is completing work on the rebuilding of the portion of its local mills recently destroyed by fire with loss reported at close to \$100,000, including equipment. It is expected to resume regular production at an early date. The rolling mills of the company were not harmed in the fire.

The Dayton Fabricated Steel Company, Dayton, Ohio, recently organized, has taken over a portion of the former local plant of the Barney & Smith Car Company on Monument Avenue, and will operate a works for structural steel fabrication. Necessary equipment will be provided at an early date, when production will be started. The new company is headed by William H. Ortman and R. S. Shonk, who

will act as president and secretary-treasurer, respectively.

The Tampa Steel Products Corporation, Tampa, Fla., lately organized, is said to be arranging for the early construction of its proposed plant at Sulphur Springs, near Tampa, where a large tract of land has been purchased. The works will consist of several mills, including 8-inch and 20-inch units; open hearth furnaces and auxiliary structures, with reported cost placed at close to \$650,000. The Tampa Industrial Development Corporation, F. H. Wolfe, president, is interested in the project.

The National Tube Company, Pittsburgh, Pa., has perfected plans for the installation of additional equipment at its mills at Lorain, Ohio, to include new blast furnace turbo-blowers to replace present gas engine reciprocating apparatus, and other equipment to provide for increased efficiency. The new blowers will have a rated capacity of 80,000 cubic feet.

The Seamless Steel Products Company, Milwaukee, Wis., has plans for the immediate construction of a new addition to its plant at Twenty-seventh and Greves Streets, to be one-story, 50x90 feet, reported to cost close to \$50,000, including equipment. The building work will be carried out by the Meredith Brothers Construction Company, 253 Washington Street. E. J. Lansing is president.

The Tennessee Coal, Iron & Railroad Company, Birmingham, Ala., has completed the construction of a new sheet mill at its plant and plans to place the unit in service at an early date. It will provide for large increase in capacity at the plant, which is now running full at all other mills. The new unit is said to represent an investment in excess of \$450,000.

The Millard F. Wilfong Iron Works Company, Fifty-second Street and Grays Ferry Avenue, Philadelphia, Pa., has plans in preparation for the rebuilding of the portion of its local plant recently destroyed by fire with loss reported close to \$50,000. Heacock & Hokanson, 1218 Chestnut Street, are architects. J. R. Wilfong is president.

The Mohegan Tube Company, Scott Avenue, Brooklyn, N. Y., manufacturer of steel tubing, has completed plans and will begin the erection of a new five-story mill at Scott Avenue and Meserole Street. It will be 90x280 feet, estimated to cost about \$125,000, without equipment. A list of machinery to be installed will be arranged at an early date. The construction will be handled by the Commonwealth Engineering Company, 103 Park Avenue, New York.

The Illinois Steel Company, Chicago, Ill., has work under way on the installation of additional equipment at its South works, consisting of a 40-inch reversing blooming mill, two high, and auxiliary equipment. Complete electrical equipment will be installed for the new unit, comprising a 7,000-hp. reversing motor, with flywheel motor generating set, control devices, and accessories. Contract for the apparatus has been let to the Allis-Chalmers Manufacturing Company, Milwaukee, Wis.

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